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AMERICAN PRACTICE OF SURGERY

A COMPLETE SYSTEM OF THE SCIENCE AND ART OF SURGERY, BY REPRESENTATIVE SURGEONS OF THE UNITED STATES AND CANADA

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PART XVI.

REGIONAL SURGERY.

(Continued.)

PROSTHESIS IN ITS RELATION TO SURGERY OF THE FACE, MOUTH, JAWS, AND NASAL AND LARYNGEAL CAVITIES.

By CHARLES R. TURNER, D.D.S., M.D., Philadelphia, Pa.

Prosthesis may be defined as the replacement of missing tissues of the body by artificial means. This definition is not intended to include the use of materials which subsequently are removed by absorption.

The replacement of tissues of the human body which have been lost by accident or disease belongs either to the domain of surgery or to that of prosthesis. Surgery, as it is represented in the great number of plastic operations in which deficiencies of substance are remedied by the transfer of living tissue from another portion of the body or from that of another person, is the more desirable means of correcting these defects. Its field, however, is largely the repair of surface areas, and is not so much that of restoring body contours, nor of providing skeletal support for the soft parts, nor of the restoration of function where highly specialized tissues have been removed. Prosthesis, on the other hand, has for its service the piecing out of deficiencies in tissue, or the masking of certain losses in substance, or the restoration of the functions of the lost parts by the use of artificial substitutes.

It is obvious that, in all instances in which a plastic operation can be done which will be successful in restoring the function of the lost part, the surgical procedure is to be preferred, since the repaired area becomes a vital part of the organism. However, in cases in which there has been great loss of substance or in those in which the function of the missing tissue cannot be restored by surgery, prosthesis offers the only hope, and in many instances is capable of making satisfactory restitution.

Frequently prosthesis and plastic surgery may be combined, as when in rhinoplasty a bridge for the nose, made of silver and anchored in the neighboring facial bones, provides skeletal support for the soft tissues which are transferred from another portion of the face.

Types of Prosthetic Apparatus.—A broad view of the subject must recognize as one of its most fundamental considerations the relationship existing between the substitute and the tissues with which it is in functional contact. Viewed from this standpoint, prosthesis may be of various kinds, as exemplified by the following different types of apparatus:—

1. An apparatus that is completely embedded in the tissues and has no communication with the exterior. The conditions necessary for the success-

ful practice of this means of prosthesis are that the operation shall be done aseptically, that the appliance shall be constructed in such form and of such materials as will be tolerated by the tissues, and—in order to insure its immobility—that it shall be attached to the bony skeleton by means which experiment and experience have demonstrated to be efficient.

2. An apparatus that is embedded in the tissues, but communicates with the exterior of the body either directly or indirectly—for example, through a cavity that is lined with mucous membrane. In this instance the appliance is not removable. Experience has proven that such appliances are impracticable, for they either have to be removed because of the infection which inevitably occurs or they are ejected by the inflammation resulting from such infection.

3. An apparatus that takes the place of some internal structure like the jaw, as in resection of this bone. The artificial substitute, in cases of this nature, is placed originally in a wound that communicates with the mouth, and then the wound is permitted to heal by cicatrization. The appliance is so constructed that, after the wound has thoroughly healed, it may be removed for purposes of cleanliness.

4. An appliance that can be placed beneath the periosteum, to serve as a sort of framework or support for newly forming bone. There are three kinds of such appliances—one that is intended to remain during the life of the individual, a second which is to be removed after the lapse of a certain length of time, and a third which is composed of material that eventually is absorbed.

5. An appliance that is placed in some cavity of the body which is lined with mucous membrane. Such an appliance must be composed of a material that will not irritate this membrane, and it must be removable for hygienic purposes. As examples of such an appliance may be mentioned the ordinary dental plate and the artificial eye.

6. An appliance that gets its support from the cutaneous surface of the body. Artificial limbs, for example, derive their support in this manner. In a few cases the apparatus may combine the characteristic features of this and of type 5.

7. Another method of prosthesis is that which consists in injecting a plastic material like paraffin into the tissues with a view to restoring contour. As this method, however, is not free from danger, it has been to a large extent discarded.

Conditions in which Prosthesis Proves Useful. Prosthesis finds its special field of usefulness in the region of the face, where preservation of form and function is so necessary; and it is thought wise, in discussing the replacement of tissues that have been lost in this region through accident or disease, to treat first of dental prosthesis and to outline the principles upon which its work is done, inasmuch as they are fundamental to all branches of prosthesis.

The frequent necessity for substitutes for the lost dental organs has created a branch of practice in which these principles have been extensively elaborated; and since the surgeon will probably in no instance undertake the construction of a prosthetic appliance, and since the training of the dentist especially fits him to undertake such work, it is believed that the best results, in cases of prosthesis about the face will be obtained by a conference between the surgeon and the dentist.

I. DENTAL PROSTHESIS.

The *raison d'être* for dental prosthesis is the loss of the teeth as a result of the diseases to which they are subject or from the occasional accidents which result in their removal. The first is by far the more common cause.

Caries of the teeth, a disease in which the lime salts are removed by the acid products of bacterial action, has been denominated the most widely occurring human disorder, and statistics confirm the accuracy of the statement. While its existence is by no means confined to modern times,* yet it is more prevalent under the conditions of modern civilization. The advent of cooking and of the mechanical preparation of food has reduced the function of the masticatory apparatus, and, as a result, it has deteriorated in structural strength and, besides, its environment has become more favorable to the action of caries-producing bacteria. The teeth of primitive man commonly wore out in masticating the coarse food of which he partook, but those of the present man are usually lost from pathological causes before old age is reached.

Next to caries, pyorrhœa alveolaris—a disease in which the retentive tissue of the tooth degenerates and eventually permits the tooth to lose its attachment to its bony socket—is most often responsible for the loss of the teeth. Lack of hygienic care of the mouth is a strongly predisposing factor in both of these diseases, and, while they are most prevalent among the poorer and more ignorant classes,—*i.e.*, among people who can rarely avail themselves of the services of a dentist,—yet this is not universally true. The loss of the teeth from these causes often occurs despite the best dental treatment. And although dental pathology and therapeutic measures have made advances quite apace with those made by other branches of medical science, it is beyond the hope of the most sanguine that the time will ever arrive when there will be no need for dental prosthesis.

The Various Bodily Disorders that Result from the Loss of the Teeth.—Loss of the teeth is followed by the crippling of the masticatory function, by more or less interference with speech and with the expressive movements of the face, and by an alteration of the facial contours that frequently changes in a marked manner the appearance of the individual. The disabling of the masticating function, however, should be reckoned as one of the most serious results. Under normal conditions the food is crushed, cut, or torn into small particles by the masticating apparatus, during which operation it is mixed with saliva which dissolves some of its soluble constituents, adds a digestive ferment, ptyalin, and agglutinates and lubricates the mass for deglutition. Interference with this function seriously affects the subsequent stages of the digestive proc-

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*The teeth of Egyptian mummies and of skulls exhumed from Etruscan and Phœnician necropoles exhibit, in many instances, the effects of caries.

Baron Oefele* has shown that, in those who have lost their molar teeth, there is a marked reduction in the ability to digest starches. The food not having been properly subdivided, masses are introduced into the stomach which are too large to receive the effects which the gastric juices normally produce. This entails too great a demand upon the stomach, and as a result there are, first, retention of food, with fermentation, and subsequently chronic gastritis and the various intestinal disorders that commonly accompany functional derangements of the stomach.

The chronic disorders of the stomach and intestines so often observed in edentulous patients are, as a rule, promptly relieved by the insertion of satisfactory artificial teeth.

The interference with speech caused by the loss of the teeth is less important than the interference with mastication, because the oral portions of the apparatus that is concerned with the function of speech can quite readily compensate for such defects in the majority of cases. But when the front teeth are lacking and the alveolar process has been absorbed, the lips and cheek fall in and the articulation of some of the sounds is rendered difficult. Thus, it is particularly difficult for persons having such defects to give proper value, in their enunciation, to the consonants F, V, S, and Z. The absence of the molar teeth may prevent the formation of the needed air-channel between the tongue and palate vault and may thus interfere with the pronunciation of the T, D, P, B, Ch, and J sounds.

Those expressive movements of the face in which the muscles centring in the orbicularis oris participate are seriously limited, and in some instances almost entirely prevented, by the loss of the teeth and alveolar process, because the lips and adjacent cheek tissues which overly these structures fall laxly into the oral cavity, and the contractions of the muscles radiating from the orbicularis oris cannot have the same effect as when they draw the tissue over a supporting framework.

Finally, the fixed expression of the face is much altered by the loss of the teeth (Figs. 1 and 2); the jaws approach nearer, the upper to the lower, the lips and cheeks fall in, and the profile and contours of the lower third of the face are noticeably changed. This alteration of appearance is even more evident when the face is not in repose, and especially so when the parted lips disclose the absence of the teeth.

It is with the repair of these deficiencies that dental prosthesis has to do. While it would seem ideal if the places of the lost teeth might be taken by teeth implanted therein, yet such method of treatment is suitable only for a few cases in which a single tooth has been lost; and even in these the percentage of failures and the comparatively short life of the implanted tooth do not warrant the frequent employment of the method. These restorations must be attained by artificial means.

Dental prosthetic appliances range from single crowns supported upon natural roots to full upper and lower dentures which are in contact with and supported upon the mucous membrane of the jaws. A number of considerations enter into the design and construction of these fixtures. Inasmuch as the appliance must be in contact with the mixed saliva and with the various food stuffs, it must be constructed of materials which will be in no way altered in such environment. If the appliance is permanently fixed to the natural teeth or roots, as are artificial crowns and some classes of bridge-work, the considerations just brought forward assume a greater importance than when the apparatus is removable from the mouth at will. This quality of removability is strictly necessary in the case of all artificial plate dentures and in that of the so-called "removable bridge-work," and is an advantageous hygienic arrangement in so far as it permits the thorough cleaning and sterilizing of the appliance.

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*The Dental Record, vol. xxv., p. 160.

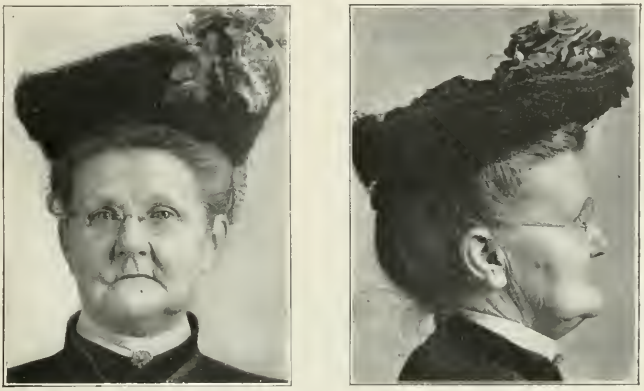

Fig. 1. Fig. 2.

Figs. 1 and 2.—Edentulous Patient. Full-face and profile views. ("American Textbook of Prosthetic Dentistry.")

The Materials Used in Dental Prosthetic Appliances.—The materials in common use are the metals, such as gold, silver, platinum, and iridium, and some of their alloys; the metals aluminum and tin and some of their alloys, as also vulcanite and porcelain, are used less extensively. Gold in degrees of purity down to 16 karats ($66\frac{2}{3}$ per cent) may be used in the mouth, although some of the less pure grades, which contain a large proportion of copper, become discolored in the mouth from the oxidation which takes place. Silver is used either in a pure state or alloyed (ninety per cent, as in coin silver). Platinum and iridium are used either separately or combined. The metals aluminum and tin and their alloys are little used and only for dental plates which may be readily removed and cleaned.

Vulcanite is practically unchanged by the oral secretions, but, if the process of vulcanization has not been properly carried out, the material is porous and unsuitable for use. Under such circumstances vulcanite absorbs the secretions, which ferment and render it utterly unfit for use. In addition, G. V. Black has called attention to the presence of bacterial colonies on plates that are sufficiently rough to afford them lodgment. He adds that when such plates are allowed to remain in contact with the mucous membrane they keep it continually irritated by the products of these germ colonies, and so produce the condition to which the term "rubber sore mouth" is often applied. Lack of cleanliness on the part of the wearer is largely responsible for this state of irritation. Formerly it was supposed that vermilion, the sulphuret of mercury, which is used as a coloring matter for vulcanite, was responsible for irritation, but this substance is decomposed only at a temperature of 600° F. and is not soluble in any acid or alkali which would be tolerated in the oral cavity.

Porcelain is unalterable in the mouth, and, from the mere standpoint of hygiene, is an ideal material for dental apparatus.

Base of Support for Dental Prosthetic Appliances. Dental prosthetic appliances are supported in a variety of ways. For example, they may be placed, as artificial crowns, upon the roots of single natural teeth; or, as bridges, they may restore to functional usefulness two or more teeth, being anchored at two or more points to natural teeth or to the roots of teeth; or, finally, they receive their support from the mucous membrane of the jaws, through the medium of a dental plate which accurately fits the surface upon which it rests. Besides these there is another class of appliances which combines the principles of both methods of restoration.

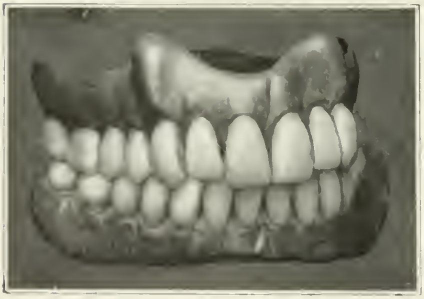

Fig. 3.—Full Upper and Lower Artificial Dentures. ("American Textbook of Prosthetic Dentistry.")

It is a fundamental mechanical principle in prosthesis that the support of a dental fixture should be adequately adapted to the strain devolving upon it in use. Thus, for dental bridges, there must be a sufficient number of natural roots for abutments, and also a dental plate the surface area of which is sufficiently large to withstand the force applied to it. A healthy root will bear from two to three times—and in some instances as much as four times—the force normally applied to it, and abutment teeth must be estimated to possess a strength similarly proportioned to the bridges which they are to bear. Normally the mucous membrane of the jaw bears without protest the pressure from a dental plate, provided the surface area of the plate is not too small. A full upper or lower set of teeth (Fig. 3) is supported properly upon the area included in the usual outline for such plates, but in partial dentures it is customary to have even a greater proportional area for each tooth. Unless provision is made for this the supporting soft tissue—whether it be that which immediately surrounds the root that carries the bridge, or whether it be some other portion of the mucous membrane—responds to the pressure by absorption; and such absorption, I scarcely need to add, must be avoided. This is a matter which requires attention in all prosthetic restorations, the aim being to distribute the pressure in such a manner that absorption of the tissues shall not take place.

Means of Retaining Dental Prosthetic Appliances.—The nature of the support selected must be such that it will not only bear the force which mastication brings to bear upon it through the appliance, but that it will also permit this appliance to accomplish its work effectively. Where natural teeth remain, they are commonly utilized for the purpose, for, being fixed in the jaws, they hold firmly in place any appliance that may be anchored to them. For example, if the appliance is a partial plate denture, the teeth serve as anchorages for clasps attached to the plate, these clasps surrounding the teeth and holding the plate in contact with the mucous membrane, but yet not permitting any pressure to be exerted upon it. In the case of crowns and bridges the teeth or their roots furnish the necessary support. In the case of an edentulous mouth it is of course necessary to depend on other means than the natural teeth for the retention of the appliance. For example, a plate may be made to adhere in a fairly firm manner to the roof of the mouth by utilization of the forces of adhesion and atmospheric pressure, and to the lower jaw by utilization of the forces of adhesion and gravity. The successful co-ordination of these forces, it is true, calls for considerable practice on the part of the patient, but eventually he acquires the needed degree of skill. It must be remembered, furthermore, that the natural conditions in the two regions mentioned are more favorable for the utilization of this method in one individual than they are in another, and that consequently

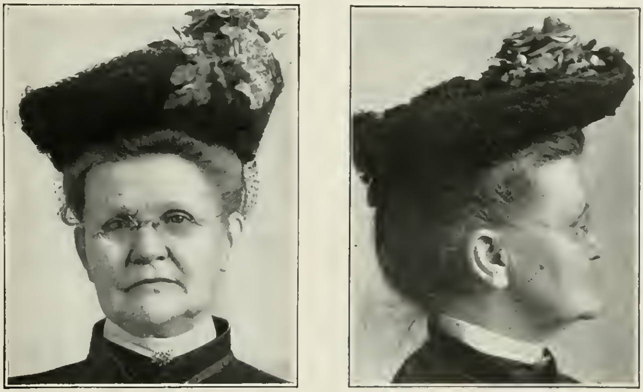

Fig. 4. Fig. 5.

Figs. 4 and 5. Front and Profile Views of the Face, to Show the Decided Cosmetic Improvement Effected by the Introduction of Artificial Teeth. ("American Textbook of Prosthetic Dentistry.") Compare with Figs. 1 and 2.

the task of learning how to make effective use of the artificial substitute is more difficult for one person than it is for another.

Restoration of Functions by Plate Dentures.—As the effect upon mastication is the most important of the sequelæ of the loss of the teeth, this should receive first consideration on the part of the dentist. In every case, however, there is more or less of a balancing of this with the cosmetic demands upon the appliance. The utilitarian purposes of the denture are served by so arranging the artificial teeth that they shall accord in general with the plan of an ideal or typical denture; the essential difference between the two consisting in the fact that the artificial teeth are not fixed in the bone, but are mounted on a movable base-plate. (Fig. 3.) The cosmetic purposes of the denture are served by selecting teeth which shall be harmonious with the other features of the patient as regards temperament and age, by arranging them in a natural manner, and by grinding them to such an extent that they shall exhibit the degree of wear which might be expected in a patient of similar age. Furthermore, the contours of the plate should restore the fixed expression of the face and permit the facial movements of expression. (Figs. 4 and 5.)

After the dentist has done all that he can in the way of providing an effectively constructed appliance as a substitute for the natural organs, the patient will, in a majority of cases, have to learn much in order to be able to use it. It is necessary for him to acquire the power of co-ordinating the muscles of the tongue, lips, and cheeks in such a manner that the plates may be maintained upon the jaws which support them, that the crushing stress of the levators of the mandible shall not be permitted to displace the plates but shall rather tend to maintain them in their places, and that the food shall be manipulated between the crushing surfaces to best advantage.

If dental prosthesis is to be conducted in a successful manner careful consideration must be given to the following matters:—Due provision must be made for the maintenance of strict hygiene; the materials used in the mouth must be in all respects innocuous; and both the utilitarian and the cosmetic purposes of the appliance must be kept fully in mind.

II. THE MECHANICAL APPLIANCES FOR TREATMENT OF CLEFT PALATE.

Introductory Remarks.—The speech of persons with congenital cleft palate is in most cases seriously interfered with. In the formation of all of the consonants except M, N, and Ng, normally the soft palate is elevated to touch the posterior pharyngeal wall, thus separating the oral and nasal cavities. In the formation of the K and G sounds, the dorsum of the tongue arches up to touch the soft palate. A defect of the soft palate affects these sounds and also imparts to the voice a nasal quality which is due to inability properly to close the nasal chambers. Under these circumstances D sounds like N and B like K, and the patient is usually unable to enunciate K and G and oftentimes also S, T, and Ch. When such patients acquire intelligible speech, they do so by the use of muscles other than those normally used. It is not uncommon for them to speak so well as to cause wonderment. The character of a palatal defect is no index as to the nature of the deficiencies in speech. Kingsley describes a case in which a patient pronounced perfectly the K and G sounds, which most patients thus affected are unable to pronounce, and he discovered that the person did so by applying the tip of the tongue to the pharyngeal wall, and not to the palate. The compressor nasi muscle is often used by patients to contract the nasal orifice, with a view of shutting off the sound from the nasal passages. Usually in these cases the muscles about the fauces and the upper pharynx are much developed, this being especially true of the palato-pharyngeus and superior constrictor muscles.

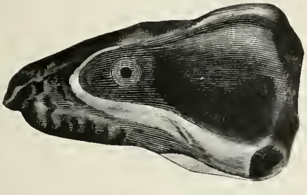

FIG. 6.—Hollow Rubber-bulb Obturator, Viewed from Above. ("American Textbook of Prosthetic Dentistry.")

The speech of persons with acquired defects of the palate is often worse than that of persons with congenital defects, for, having learned to speak with a normal structure, they find it difficult to do so when this structure becomes defective. But, when the defect is repaired by mechanical means, these patients at once articulate satisfactorily.

It is probably safe to say that, in a majority of the cases in which the patient can be operated on successfully in the first two or three years of life, surgery offers possibilities of greater benefit than can be secured by the utilization of any mechanical device.

For full details with regard to the pathology and operative treatment of cleft palate, the reader is referred to the article devoted to this subject (Vol. V.).

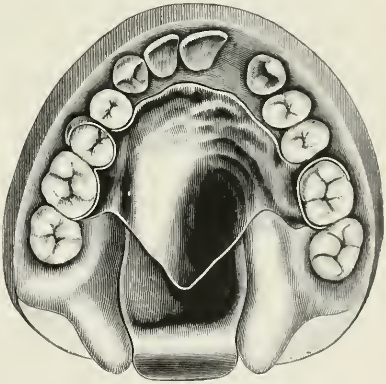

FIG. 7 Obturator and Supporting Plate in Place ("American Textbook of Prosthetic Dentistry.")

There are two generally accepted types of appliances used for remedying palatal defects—the obturator and the artificial velum. There are fundamental differences in the manner in which these two appliances operate for the betterment of speech.

The Obturator.—As its name implies, the obturator is an agent designed to fill the opening of the cleft; it is the older of the two instruments. Dr. William Suersen, in 1867, described his obturator before the Central Association of German

Dentists at Hamburg, and it was he who first put the use of this appliance upon a scientific basis. At the present time instruments constructed upon the principles enunciated by him are in common use. The obturator, then, is an instrument which fits the cleft and restores the palatal vault. It is so shaped that, during the movements of the sides of the cleft, the appliance continues to remain in contact with the parts. (Figs. 6, 7, and 8.) Its posterior edge does not reach the pharyngeal wall when the muscles are in repose, and consequently the instrument permits the respired air to pass properly through the nose. When it is necessary that the channel of communication between the oral and nasal cavities should be closed, contraction of the superior constrictor of the pharynx causes the pharyngeal wall to bulge forward and come in contact with the posterior extremity of the obturator. Such a shutting off of the oral cavity from the nasal cavities takes place, for example, when all the consonants, except M, N, and Ng, are enunciated. In the production of these sounds nasal resonance is necessary, and the passage of communication between the mouth and the nose is then left open through the inactivity of the superior constrictor. The oral side of the obturator furnishes a surface for the tongue to touch when K and G sounds are produced.

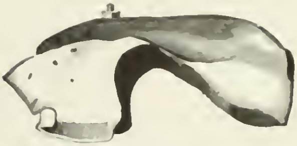
FIG. 8.—Profile View of Obturator and Supporting Plate. ("American Textbook of Prosthetic Dentistry.")

The Artificial Velum.—The artificial velum, the first use of which is attributed to Delabarre, exhibits its most satisfactory development in the "velum of Kingsley"—an appliance which is in general use at the present time. The artificial velum is constructed of soft flexible rubber and is an attempt to imitate the missing tissue by means of this material.

"The essential requisite of an artificial velum is to replace, as far as possible, the natural form of the defective organs with such material as shall restore their functions. Muscular power certainly cannot be given to a piece of mechanism, but the material and form may be such that it will yield to, and be under the control of, the muscles surrounding it, and thus measurably bestow upon it the function of the organ it represents." (Kingsley.)

The Kingsley velum (Fig. 9) consists of two triangular flaps, one of which, the nasal, bridges over the cleft in the soft palate and is in relation with the upper surface of its sides, while the other, the oral, restores the palatal vault and is in relation with the lower surface of the edges of the cleft. These flaps are united along their median line, and this line of union occupies the centre of the cleft. The sides of the upper flap, which extend about half an inch beyond the edges of the cleft, roll upward, while its posterior edge curves downward and,

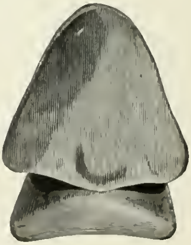
FIG. 9.—Soft-rubber Velum of the Kingsley Pattern. Upper and posterior surfaces. ("American Textbook of Prosthetic Dentistry.")

approaching the pharyngeal wall obliquely, terminates about one-quarter of an inch from it. (Fig. 10.) (These measurements vary in different cases.) The lower flap overlaps the edges of the cleft just as does the upper one, but it extends posteriorly only to the base of the uvula. Its under surface is curved in such a manner as to complete the palatal vault, and must be of such form that it may be reached by the dorsum of the tongue in the articulation of the K and G sounds. The edges of the cleft occupy the groove-like spaces between the flaps, these spaces being of such shape that the edges of the cleft may slide in them as the action of the palatal muscles causes the edges to separate or to come together. At the same time the sides of the groove hug the cleft borders so tightly that air is not permitted to escape between them. (Fig. 11.) The posterior portion of the upper flap, which becomes very thin and flexible at the extreme edge, is extended until it nearly touches the posterior pharyngeal wall. While the palatal muscles are in repose the air current can pass readily through the nose, but, when these muscles contract, the edges of the cleft are borne upward and backward and the soft-rubber velum is carried up by them, its posterior edge being brought against the wall of the pharynx which bulges out to meet it through the contraction of its superior constrictor muscle. If the artificial palate is to be serviceable it must be adjusted by the palatal muscles until it is capable of preventing the passing of air into the posterior nares.

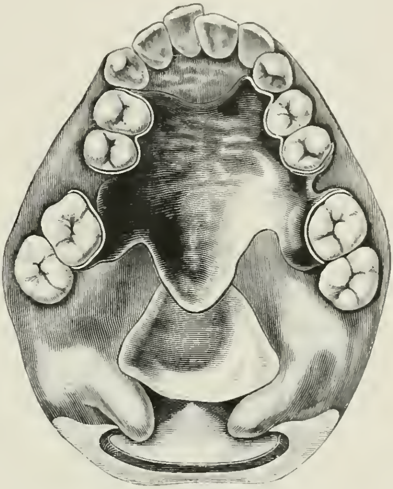

FIG. 10.—Soft-rubber Velum and Supporting Plate in Place. ("American Textbook of Prosthetic Dentistry.")

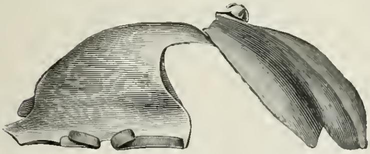

FIG. 11.—Profile View of Soft-rubber Velum and Supporting Plate. (Ottolengui.)

From this description it should be possible to understand the manner in which the artificial velum operates. Thus, for example, when the palatal muscles are in repose the artificial velum, owing to the fact that it does not under these conditions extend to the pharyngeal wall, permits respiration to be carried on through the nose and sounds that require nasal resonance to be articulated. On the other hand, when these muscles contract, as they do during deglutition, the opening into the posterior nares is completely closed

It is also completely closed during the articulation of the K and G sounds, both of which sounds require such complete closure.

The Obturator-Velum.—Within the last few years Dr. Calvin S. Case has presented a new artificial palate which has been called an "obturator-velum" because it combines the principles of both appliances. (Figs. 12–15.) Dr. Case describes the instrument in the following terms:* "Through a desire to take advantage of the benefits conferred by a soft-rubber appliance on the one hand, and by a hard-rubber obturator on the other, and at the same time to avoid the possibilities of the final inefficiency of the one and the difficulties in construction and adjustment presented by the other, has arisen the present artificial palate, which it is the object of this paper to present.

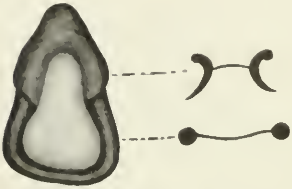

Fig. 12.—Velum-Obturator of Case. Upper and sectional views. ("American Textbook of Prosthetic Dentistry.")

"It essentially consists of a form of palate which can first be made of soft rubber and which possesses all the advantages of the Kingsley velum, but which, when the patient has become accustomed to it in its flexible state and when its form is an assured success, may be exchanged for one of harder consistency—one that is obtained by packing the same cast in which the soft-rubber palate was vulcanized with another quality of rubber. There will thus be produced a hard-rubber palate, one which possesses all the advantages of a perfect obturator.

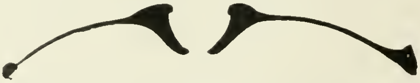

Fig. 13.—Case's Obturator-Velum. Antero-posterior sections. ("American Textbook of Prosthetic Dentistry.")

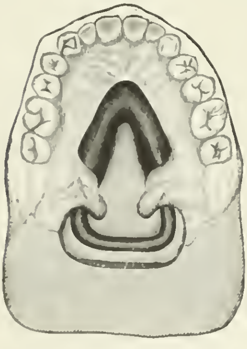

Fig. 14.—Case's Obturator-Velum in Position. ("American Textbook of Prosthetic Dentistry.")

"If made of soft rubber, the first palate can be worn without irritation or inconvenience (as regards speech); after which the desired changes in its form, such as are nearly always required to perfect the palate, can be easily made by slightly enlarging or contracting the metal mould in which it was originally vulcanized.

"Those who are familiar with the Kingsley palates—which, I am pleased to say, I have used with great satisfaction in my practice for over twenty years—will remember that the veil or posterior portion of the palate is sustained by extending the central thickened portion into it, and that from this point it is gradually flattened to a comparatively thin edge, where it is more or less curved in conformity to the pharyngeal wall, against which it is intended to rest during the contraction of the pharyngeal and the palatal muscles.

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*Slightly modified in a few places by the author with the object of securing greater clearness.

"In this particular the Kingsley palate is quite different in form from the palate I am about to describe, in that the central part of the latter is thin, while the edge of the veil has the form of a solid roll about one-fifth of an inch in diameter, or, preferably, that of a three-sided prism with rounded margins, so that its outer flattened surface exactly and firmly fits the pharyngeal walls when the muscles are in a contracted state.

"In extensive clefts the borders of the veil extend forward along the lateral walls of the pharynx and posterior nares, and, becoming thinner, form the borders of the nasal extensions which rest upon the floor of the nares.

"When the cleft does not extend into the hard palate, the veil is shaped in a similar manner, but with the nasal portion abridged to meet the requirements of the case.

"When the cleft extends into the hard parts, the body of the palate, which covers the borders of the cleft and forms the lateral wings on the roof of the mouth, should not extend back of the attachments of the bifurcated velum palati, nor in any way interfere with the free action of the muscles; neither should it extend upon the roof of the mouth any farther than is necessary to give a firm seating for the palate. This portion should be about as thick as an ordinary rubber plate, being thinned along its oral borders and thickened to form the nasal borders.

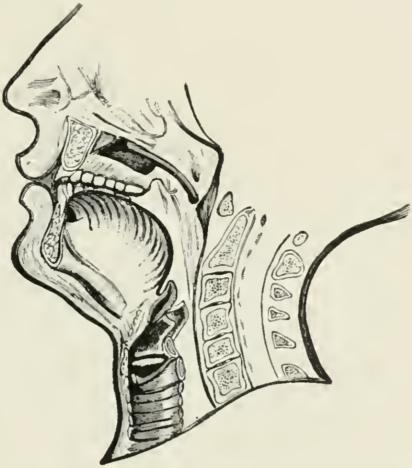

FIG. 15.—Sectional View of Head with Case's Obturator-Velum in Position. The diagram shows the relation of its posterior edge to the bulging of the pharyngeal wall caused by the contraction of the superior constrictor muscle. ("American Textbook of Prosthetic Dentistry.")

"There are a number of important advantages in the form of palate which I have here described, even when it is made of flexible rubber and is used for the purposes of a velum. These advantages are:—

"First. The early deterioration of the rubber, which causes the thin edges of the veil to curl over, is entirely prevented. When the curling occurs, as it frequently does with ordinary vela, the usefulness of the palate, as regards speech, is impaired in direct proportion to the extent to which it permits the escape of air at the curled-up portions of the border.

"Second. The heavy border of the veil is sufficiently yielding and flexible to be worn with comfort if properly fitted, and it also presents sufficient stability and breadth of surface to permit firm contact of the parts when the pharyngeal muscles close the naso-pharyngeal opening.

"Third. In more or less extensive clefts the thin central portion that tends forward into the body of the artificial palate, permits a resilient yielding of the lateral portions of the body, and this yielding frequently allows the surgeon to spring the appliance into place in such a manner that its irregular borders, which should adapt themselves accurately to the parts upon which they rest, will hold it in position without the aid of a supporting plate. Whenever this can be accomplished with the artificial palate in its soft form, one may confidently expect that the same result will be attained when the hard form of palate is substituted."

Except in a few instances in which Case's velum-obturator does not require it, all types of artificial palates are supported in place by being attached to dental plates, preferably those of metal. (See Figs. 7 and 10.) Frequently, in cases of cleft palate, certain teeth are missing in the dental arch, and this is usually the case when the cleft passes through the arch anteriorly. The places of such missing teeth should be supplied by artificial ones attached to the plate. When no teeth are missing, the plate is made only of sufficient size to carry the artificial palate, and, in order to secure its stability, it is anchored by means of clasps to selected natural teeth. The clasps employed are made of spring-tempered platinous gold, and one such clasp fits a molar tooth on each side of the mouth. It is a better arrangement to adjust gold cap-crowns over the anchorage teeth and to fit the clasps around these crowns, for by this arrangement the teeth will be protected from the mechanical abrasion of the clasps. The plate completely covers any cleft that may exist in the hard palate, and to its posterior end is attached the obturator or the velum. If the cleft involves only the soft palate, the plate should extend posteriorly beyond the beginning of the cleft, and the artificial palate should be attached to the upper surface of the extension by a bolt or a headed pin. Gold and iridio-platinum are preferred as the materials for the plate.

Owing to the impossibility of making a useful classification of acquired defects of the palate, by reason of the fact that no two cases present the same features, it is not practicable to discuss the appliances which may be employed for their treatment except in the most general manner. In the case of a simple perforation of the hard palate, a dental plate covering the roof of the mouth and bearing a plug that accurately fits the opening is all that is generally believed to be necessary. There are many surgeons, however, who now regard it as being wiser not to fit a plug into the opening, as the pressure exerted by the plug causes absorption of the borders of the opening and thus leads to an increase in its size. The better course, as they believe, is to aim at effecting a closure of the opening by the application of an accurately fitting plate to the vault of the mouth. It is pointed out that Nature, when thus aided by artificial means, often reduces a defect of this kind to a minimum.

When the soft tissues alone are involved recourse may be had either to the hollow bulb obturator or to any form of substitute specially designed for the requirements of the case in hand. The general principles already outlined for the use of obturators in congenital cases will be found useful in the treatment of the acquired defects.

Impressions for cases of cleft palate are difficult to take, and it is unnecessary to describe the technique of taking them in a work of this character. Suffice it is to say that the difficulty of securing an imprint of the sides of the cleft of the soft palate when they are in repose is due to their extreme sensitiveness. When the impression material, plaster of Paris, is introduced, the palatal muscles contract, raise the sides of the cleft, bring them nearer together and cause their edges to become thicker. The model secured from such an impression must be altered subsequently to overcome these defects. In fissure of the hard palate, there is no necessity for including its sides in the impression, especially as some of the plaster may thus be forced through the opening into the nasal cavities, from which region it is not always easy to dislodge it. This danger may be avoided by filling the opening with cotton, or by laying a narrow strip of bibulous paper over the plaster before it is applied, the paper preventing the forcing of plaster through the fissure.

The Kingsley velum is constructed of soft vulcanite, this material being cast in type-metal moulds which are preserved in order that new vela may be easily made. A model of gutta-percha is first made on the plaster cast, and when this has been found satisfactory, after frequent trial in the mouth, it is used for obtaining the type-metal moulds. The soft rubber must be specially prepared for such purposes and it must be carefully vulcanized, or it will become worthless in a short time.

The obturator is in the form of a hollow bulb of hard rubber. This gives it lightness and the hard rubber is very durable. In order to get a model for it the following steps are necessary:—The supporting plate having been made, to its posterior portion is attached a wire loop about which is formed a lump of soft modelling compound. This portion is made very soft by heating and is then carried quickly to the spot in the mouth where it is to be moulded, the patient being requested to swallow several times while the material is being pressed into shape. By this means the palatal muscles give it approximately its proper form. Afterward, however, it will be necessary to do a certain amount of trimming. Thus, for example, the upper surface needs to be trimmed flat, while the lower or oral surface must be trimmed in such a manner that it shall complete the vault of the mouth and at the same time be within reach of the tongue when it is necessary to pronounce the K and G sounds. Finally, the sides and posterior edge must also be slightly trimmed, as the muscles cannot completely shape these surfaces. The model thus obtained is duplicated in vulcanite as a hollow bulb by first obtaining a plaster matrix in an ordinary dental flask, and by placing in this a bag of vulcanizable rubber made from sheet rubber, in approximately the shape of the model, the bag being sealed and being about three-quarters full of water. In the process of vulcanizing, this water is converted into steam, by the expansion of which the bag is made to fill the matrix. After the vulcanizing is completed this water is removed and the holes are plugged up.

Relative Advantages of Oburators and Vela.—Were it not for the fact of the deterioration of the soft rubber of which artificial vela are constructed, it is likely that this appliance would be preferred to the obturator in most cases of cleft-palate, because with it patients speak more nearly in a normal manner. The length of life of a velum varies from three months in some mouths to two years in others, being largely dependent upon the state of cleanliness in which it is kept. Its durability depends also upon the quality of the rubber employed and upon the care with which it has been vulcanized.

Patients are not only able to speak in a more nearly normal manner with a velum than with the obturator, but it has been ascertained by experience that they more rapidly acquire speech with this type of appliance. It is also a clinically observable fact that the tissues in the vicinity of the cleft are usually in a slightly inflamed condition from contact with the food and from the abnormal manner in which air passes over these parts. Tissues in such a state take more kindly in the beginning to the soft than to the hard rubber appliance. Most patients, after they have once learned to speak with a velum and have become accustomed to the presence of a foreign body in the part, are soon able to speak well. A properly designed obturator, constructed of hard rubber, is indestructible and may be looked upon as a permanent appliance.

Age at Which an Artificial Palate Should be Introduced.—While it is advantageous to introduce the artificial palate as early in life as possible, in order that the patient may acquire the use of it during the formative period of speech and thus have only a few incorrect methods of speech to unlearn, yet expediency seldom warrants its introduction before the sixth or seventh year. By this time the first permanent molars have erupted and can serve as a secure means of attachment for the plate carrying the palate. Furthermore, before this time the patient is unable to appreciate the purpose of the appliance.

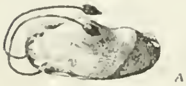

FIG. 16.—Artificial Palate for the New-born, Permitting Suction. A, Soft-rubber termination to allow movement of muscles of the soft palate. Rubber-tipped springs entering nostrils to support the appliance. (Claude and Francisque Martin.)

The successful use of an artificial palate depends primarily upon its being constructed of a form that will meet the requirements of the case in hand; but a no less important consideration is the acquisition, on the part of the patient, of the ability to use it properly. The cultivation of proper muscular co-ordination depends largely upon the patient's ambition, upon his or her mental calibre, and upon proper training in the establishment of correct speech habits. Many a correctly constructed appliance has been discarded as valueless because the patient did not persevere in learning to use it.

Various means have been utilized in teaching patients to speak with an artificial palate. In the case of a young person, the mother, if she possess a fair degree of ambition, is in a position to do the most in this matter. The imitative faculty will enable the child to learn correct speech from its mother more readily than from any other source. Reading aloud for a half-hour each day and singing for a quarter of an hour daily are very useful means in this direction. In the case of an older child whose speech habits are formed, or in that of an adult, the services of a trained elocutionist will often be very beneficial. Kingsley suggests the study of some foreign language as especially valuable in this connection, for the person has to learn new sounds and in so doing forgets in some measure the old methods of speech. In a majority of the cases of acquired defects of the palate, no special training is necessary after the defect has once been remedied.

Mechanical Appliances for Cleft Palate in the New-born.—The high rate of early mortality of infants born with cleft palate is due to two facts: first, that they cannot swallow sufficient food, the cleft permitting its regurgitation through the nose; and second, that they are not able, by reason of the defect, to exert the suction necessary in nursing the mother, especially if the lip is fissured at the same time. It is evident that correction of these defects should be undertaken at an early time, and, where surgical intervention cannot be instituted, the use of some mechanical device is indicated.

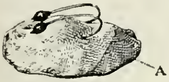

Fig. 17.—Artificial Palate for the New-born. Permitting Suction. *A*, Soft-rubber termination. Rubber-tipped springs entering posterior nares to support appliance. (Claude and Francisque Martin.)

Frequently, simple suturing of the lip will enable the child to nurse, and it soon learns to manipulate its tongue so as to close up the palatal opening in sucking and in deglutition. In some instances, if the bottle is provided with a nipple long enough to reach into the pharynx, the infant may be nourished in this manner, and in many cases it learns how, despite these defects, to obtain from the bottle enough nourishment to sustain itself.

Various devices for closing the palatal opening during nursing have been suggested—devices which are varied accordingly as the infant is to nurse at the breast or from the bottle.

Warnekros presented to a medical society in Berlin what is believed to be an example of the first attempt to make an appliance for this purpose, and at a still later date Delair and Martin proposed somewhat similar appliances. A brief description of that of Martin here follows:*—The appliance consists of a plate of hard vulcanite which closely fits the palatal vault, bridges the cleft, and terminates posteriorly in a soft-rubber edge capable of performing to some extent the functions of the natural velum. (Fig. 16.) During nursing the appliance is held in place by gold springs which terminate in soft-rubber balls, 4–5 mm. in diameter, the springs being arranged to enter the posterior nares (Fig. 16) or to pass forward into the fissure from behind (Fig. 17), while the soft-rubber extremities sustain the apparatus by gently pressing on the nasal floor. In another method suggested the support is afforded by soft-rubber projections that fit the edges of the cleft. (Fig. 18.) These appliances are suitable for cases without hare-lip or where the lip has been sutured.

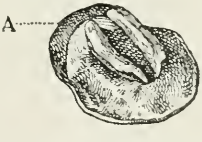

Fig. 18.—Artificial Palate for the New-born, Permitting Suction. *A*, Soft-rubber termination. Retention by attachment over the sides of the cleft. (Claude and Francisque Martin.)

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* Le Laboratoire, Nov. 3d, 1907, p. 702.

Martin has described another appliance which he employed in a case of divided palate with double hare-lip. In this appliance, the palatal portion of which is similar to that already described, he has, on account of the extreme lack of substance of the upper lip, constructed an artificial upper lip of soft rubber. This artificial lip is hollow, is filled with water in order that it may be pliable, and it extends to the posterior extremity of the maxilla. Against this the little patient can press the lower lip and can thus exert the suction necessary in nursing.

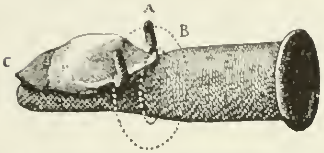

Fig. 19—Artificial Palate for New-born, Permitting Suction. Attached to rubber nipple. *A*, Projections resting on front of alveolar process to fixate appliance. *B*, rubber nipple; *C*, soft-rubber termination. (Claude and Francisque Martin.)

When from any cause the infant is to be bottle-fed, it is only necessary to interpose between the nipple and the palatal fissure a plate which will cover in the latter. For purposes of convenience this may be attached to the nipple. Coles* suggests attaching to the nipple a properly shaped piece of semi-flexible rubber which will adapt itself over the palatal fissure; Martin,† on the other hand, attaches to the nipple a palate constructed in a manner similar to that described above, except that the means of attachment to the patient are omitted, and, instead two upward projections, which are attached at the anterior border, rest upon the alveolar process and prevent the backward displacement of the appliance. (Fig. 19.)

III. PROSTHETIC RESTORATION OF THE FACE, INCLUDING ARTIFICIAL NOSES, LIPS, EARS, TONGUE, AND LARYNX.

One of the most useful fields of plastic surgery is the repair of defects incident to the loss of tissue about the face. Because this portion of the body is exposed to view, the deformities of the face resulting from accident or disease frequently consign the unfortunate victims to lives of seclusion, or they are compelled to wear unsightly bandages or masks when mingling with their fellow-men. When, from the great extent of the repair required or for any other contraindicating reason, it is not possible to remedy these defects by surgical means, it is frequently possible to disguise the deformity effectively by an artificial substitute for the missing parts. But whenever there is a choice between the two means, surgical restoration should be given the preference, for no artificial substitute can ever present the appearance of constituting a vital part of the organism.

1. **Artificial Noses.**—The part of the face which most commonly requires artificial restoration is the nose. The prominence of this feature probably exposes it to accident more frequently than any other portion of the face. The nasal bones, furthermore, are often the seat of syphilitic necrosis, which generally involves the vomer and the hard palate at the same time. Under such circum-

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* "On Deformities of the Mouth."

† *Op. cit.*, p. 706.

stances, the superincumbent soft parts—in the event of their having escaped destruction—are left unsupported, and they consequently sink into the nasal chambers. In 23 cases of destruction of the nose, reports of which were found in various publications, the causative factor was not stated in 12. In the remaining 11 cases the loss was due in 2 instances to cancer, in 4 to gunshot wounds, and in 5 to lupus. In those cases in which the loss has been caused by lupus, by cancer, or by one of the less serious forms of trauma, the destruction is usually confined to the soft tissues, while in cases of syphilitic disease and of gunshot injuries the damage done is apt to destroy the skeletal support. In cases of the latter nature the nasal opening is very likely to be blocked by cicatricial tissue, and amelioration of this condition may be required as well as interference for cosmetic purposes. The surgeon is sometimes obliged to choose between rhinoplasty with a metallic support and the application of an artificial nose.

Artificial noses have been constructed of vulcanite, of celluloid, of porcelain, and of various metals. Vulcanite is in most common use for this purpose as it is easily moulded into form, is light, and can be painted to give it a natural appearance under ordinary conditions. Its opacity and the opaque nature of the paint used in coloring it are the most serious drawbacks to its use. Celluloid was used by Kingsley, by Bruck, and by Henning, but Martin found that it underwent disintegration, and that, if the artificial nose were made very thin, it would warp out of shape after a time. The various metals, with the exception of aluminum, are as a whole too heavy, and do not hold the paint well. Porcelain has been used by Martin, who prefers it to other materials when, in a given case, its weight is not a contraindication to its use. He also prefers it on account of its translucency—a characteristic which makes it possible to obtain the best cosmetic results. The great amount of skill necessary to color and bake porcelain is a serious drawback to its general employment.

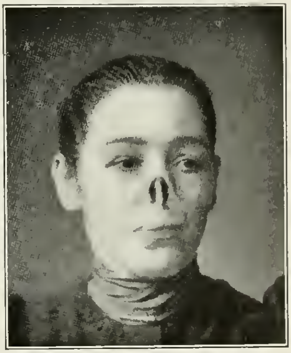

Fig. 20.—Patient with Partial Loss of Nose. (Baird: *The Dental Cosmos.*)

Various means of attachment have been utilized for holding an artificial nose in place, and these of course differ according to the conditions of each case. The device most commonly used is one in which the artificial nose derives its support in part from the floor of the nasal cavity, and in part from a spectacle frame to which the upper end of the appliance is attached. By this arrangement most of the weight of the appliance is borne by the supports in the nasal cavity, the spectacle frame assisting and serving to maintain the edges of the nose in contact with the borders of the gap in the tissues. The spectacle frame may, in certain cases, serve another useful purpose, viz., that of concealing the line of contact between the artificial nose and the living tissue. The frames may hold either plain glass or such lenses as the patient requires. Commonly the spectacle frames in ordinary use will not be heavy enough to support the appliance, this being especially true if the nose is of large size or heavy. Under these circumstances special frames with heavy ear-pieces must be obtained.

Frequently the intranasal support may be made either in the form of a tube (of gold, iridio-platinum, or block tin) through which the respiratory current may pass, or in that of a flattened piece of metal. The point of bearing must be broad in order that the weight of the artificial nose may be as equally distributed as possible. This is a very important consideration, not only from the standpoint of the comfort of the patient, but also in order that the pressure may not cause absorption of the tissue or incite irritation. It is also essential that the lower rest should accurately fit the surface upon which it is placed, as this will reduce to the minimum the possibility of irritation. It is self-evident that the supporting projection must be of a form which will readily permit the wearer to remove the nose and to restore it to its place.

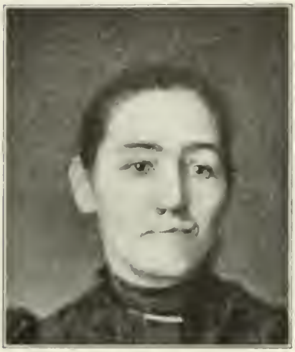

FIG. 21. Patient with Artificial Nose in Place. (Baird. *The Dental Cosmos.*)

Another means of maintaining the nose *in situ* is by the use of spring-like supports which enter the nasal opening when sprung together, and which open out when the pressure is withdrawn, thus holding the apparatus upon the face. This form of support is especially suitable for cases in which there is a large external orifice, and for those in which the bridge of the nose is still preserved—that is, in cases in which a spectacle frame, if required, would have to be placed too low to look natural; it is also suitable for cases in which a small portion of the nose is missing or in which the upper lip is intact.

If the artificial nose is very light these supports may rest against the external walls of the nasal fossæ, and they should be very broad where they are in contact with the mucous membrane of this region. They should be so adjusted that they exert a pressure only just sufficient to hold the appliance in place. It is also important to make sure that the mucous membrane, at the points where the pressure is made, is in a perfectly healthy condition and therefore not likely to be irritated by the pressure thus exerted upon it. The supports may be made of an alloy of platinum and gold so shaped as to fit the surface, or their ends may be covered with vulcanite to which a similar shape has been given.

In a case described by Schwartz* hook-like projections of ordinary vulcanite rested on the floor of the nasal fossæ, while springs tipped with hard vulcanite rested in contact with the inner surface of the nasal bones and thus held the apparatus in place.

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* Le Laboratoire, Nov. 11th, 1906, p. 671.

In some cases the teeth may furnish a lower point of support for the artificial nose. Ordinarily, this is possible only when the nasal and oral cavities communicate. A plate, which is fitted about and attached to the teeth, bears a metallic projection which enters the nasal chamber, and this forms the support of the nose. The superiority of this mode of attachment is to be found in the fact that it affords great stability for the artificial substitute. In some cases in which no opening existed between the mouth and the nasal cavity, Martin has perforated the soft tissue at the junction of the lip and alveolar process to provide for the passage of a support from the plate.

In many cases that require the application of an artificial nose it has been found necessary at the same time, on account of the presence of a perforation of the hard palate, to fit a suitable obturator. The latter instrument provided still another means of attachment for the artificial nose,—one which has been utilized by Wildman,* Hoopes,† and Martin.‡ The method, however, although offering a secure means of retention, is open to the serious objection that movement is transmitted to the nose during mastication. Martin has two ways of overcoming this difficulty: In one plan he attaches the nose to the upright piece which projects from the obturator by means of a sort of universal joint, while in the other plan he attaches a flexible spring to the top of the nose in a curving manner and so arranges it that it shall take up any motion that might be communicated through it to the artificial substitute.

The general method of constructing such an appliance will be described here in brief outlines. First, an impression of the face is taken with plaster of Paris, after the skin has been coated with vaseline and the nasal orifices have been filled with cotton so that only their margins may be included in the impression. The eyebrows should be protected by rubbing vaseline into them and by covering them with strips of cotton gauze which are thoroughly covered with vaseline. A tube made by rolling thick tinfoil about a pencil is inserted in one side of the nose or the mouth to permit the patient to breathe while the plaster is being applied to the face. As the process of taking an impression will require about twice the quantity of plaster ordinarily mixed together at one time, an assistant should be ready with the second lot to add to the first before it has thoroughly set. Nothing should be done to hasten the setting, as it will require all of the ordinary setting time of impression plaster to bring it in contact with the surface. After a cast has been obtained from the impression, a nose is moulded in wax upon the cast to serve as a model for trial on the face of the patient.

Plaster casts of noses suitable for the case in hand will serve as a guide in modelling the artificial nose, which of course should be made to correspond as harmoniously as possible with the features of the patient.

The means of attaching the nose firmly in its place having been already prepared and adjusted, they should now be added to the wax model. If a spectacle frame is to be used, some means of attaching this to the vulcanite nose must be provided, since the nose cannot be vulcanized directly to the frame.

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* Garrettson's "Oral Surgery," p. 479. † "American System of Dentistry," vol. ii., p. 1092.
‡ "De la Prothèse Immédiate," p. 263.

This attachment can be in the form of a projecting plate of metal soldered to the saddle of the spectacle frame which may be attached by screws to the completed nose, or may be soldered with soft solder to a metallic attachment which has been embedded in the vulcanite nose. The nose is then reproduced in vulcanite, and, after it has been finished and adjusted to the patient's face, it is turned over to an artist who gives it the same coloring as that which is natural to the patient. This is accomplished by the use of oil paints and is by no means an easy task. It should be remembered that the coloring of the skin of the face varies from time to time, according to the weather and the emotions, and consequently a favorable time should be selected for this purpose.

The artificial nose should be as thin as is consistent with the necessary strength. Its interior should be made without angles or recesses, in order that it may be kept in a strictly hygienic condition. This is especially necessary because the secretions of the nasal mucous membrane tend to collect on its inner surfaces. Where a tube destined to transmit the respiratory current forms a part of the apparatus, its calibre should be large enough readily to permit the necessary cleansing operations. Experience has proven that, wherever possible, this tube should be arranged so as to dip downward and inward rather than downward and outward, as in cold weather, if the tube is arranged in this manner, the condensed moisture from the expired air will run into the nasal chamber rather than drip from the nose.

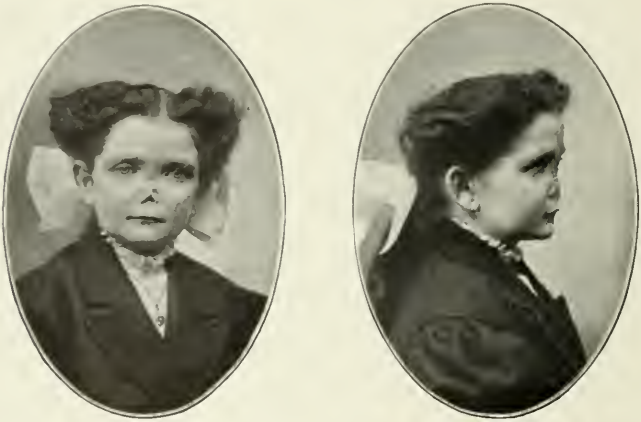

FIG. 22. FIG. 23.

FIGS. 22 and 23. Front and Profile Views of Patient with Nose Partially Lost. (Kurtz, in *The Dental Cosmos.*)

It often happens, in cases requiring an artificial nose, that a portion or all of the upper lip is also missing. This missing portion may be made part of the appliance. To add to the naturalness of this lip, in the case of a patient of the male sex, and also to conceal it as much as possible, it is usual to append an artificial moustache the hair of which should match as closely as possible that of the neighboring cheek. The lateral edges of the appliance should be made thin, in order that they may blend as naturally as possible with the cheeks, and they should not meet the latter at a right angle. For the obliteration of the line of junction Gritman has suggested the use of actor's putty, which the patient can apply each day, and, if over this he sprinkles a little face powder, the joint will hardly be visible even at very close range.

Artificial noses made of porcelain are constructed as follows:—From the completed wax model of the proposed nose, a die of zinc is cast and a counter-die of lead. Between these is stamped a thin platinum form, and upon this, after it has been filled with plaster to prevent the distortion of its form, is baked the porcelain chosen for the nose. After it has been given the correct baking and is of the correct thickness, the plaster is removed, the platinum carefully stripped off from the interior, and the glaze of the porcelain surface removed by dipping it into hydrofluoric acid. The advantage which such a porcelain nose possesses is its life-like appearance, due largely to its translucency. This peculiarity also makes it possible to put on color beneath, which by showing through may be made to match the various differences in the color of the adjoining skin.

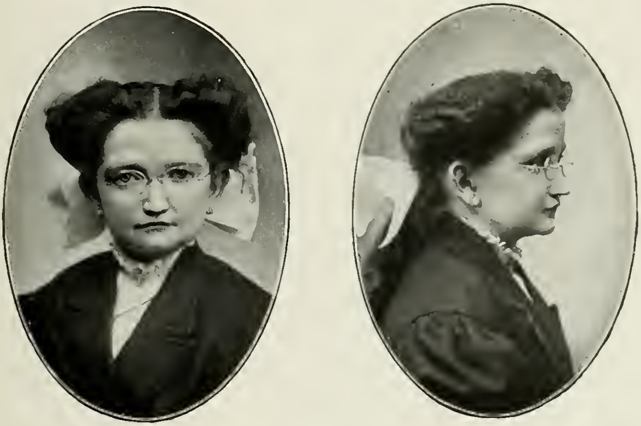

FIG. 24. FIG. 25.

FIGS. 24 and 25.—Front and Profile Views of the Same Patient (Figs. 22 and 23) with Artificial Nose in Place. (Kurtz, in *The Dental Cosmos.*)

The following are the details of an artificial nose constructed by Ph. Kurtz* for a patient, S. D., twenty-three years old, who at about five years of age lost the nasal bones and septum from necrosis following an accident. Kurtz used as the upper retainer for the nose an ordinary spectacle frame, such as may be obtained from the optician. To the under surface of the nose-piece of this was hard-soldered a piece of 28-gauge gold plate that had been made to extend down into the vulcanite of which the nose was constructed. The tissue on which the bridge was to rest being soft and flat, two pieces of 14-karat gold, 28-gauge and about one-eighth of an inch wide, were soldered to the nose-piece in such a manner that, when the contrivance was in position, they pressed gently upon the sides of the tissue, thus causing this part to resemble more closely the natural root of the nose. Two pieces of platinous gold (35-gauge) were arranged for the lower support of the piece, one extending into each nasal fossa. These were used in place of tubes in order to reduce to the minimum the weight of the fixture, to prevent irritation of the tissues from hard pressure, and also, by reason of their pliability, to permit the neighboring muscular structures to move without causing undue pressure on the parts upon which the supports rested. Another effect of these two gold pieces was to hold the artificial nose in close contact with the face, thus improving the expression of the upper lip.

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* The Dental Cosmos, June, 1908, pp. 595–598.

An impression of the face, with spectacle frame and supports in place, was taken and from the cast, along the line of the edge of the future nose, a little plaster was scraped in order to make the nose press slightly into the tissues. The cast was slightly built up at the site of the nose with plaster in order that the wax form of the nose fitting over it might be hollow. The nose was modelled in pink paraffin and wax, care being taken to make it harmonize with the features, and afterward it was reproduced in vulcanite (light pink gum rubber). The edges of the nose were adjusted to the skin of the face, and then the proper coloring was secured by the application of several coats of oil paints. After the paint was dry, the patient was instructed in the use of cosmetics, to obliterate the glossy surface and hide the joint. Figs. 22–25 show the patient before and after the application of this artificial nose.

2. **Artificial Lips.**—As a rule, the artificial restoration of the lost portions of the lips is necessitated in conjunction with some other artificial appliance of which they become a part. Many of the artificial noses which have been constructed have had attached to them artificial substitutes for some portion of the upper lip, as the cause operating to destroy the nose has also included the lip; and the necessity for artificial lips is most commonly limited to such cases, for plastic surgery has been able to make a great majority of these repairs. All hare-lip cases, for example, should be cared for by the surgeon and not by the prosthetist. It occasionally happens, however, that so much of the substance of the lip is lost—as from a gunshot wound or from the operative removal of a malignant neoplasm—that the surgeon deems it inexpedient to attempt repair of the defect by an operation; and in such instances restoration by artificial means is clearly the proper course to pursue.

The substances used for the construction of the lip or portions thereof are vulcanite, hard or soft, and porcelain. The former material is generally preferred because of its lightness, only one case of the use of the latter having been reported.

When the defect is of such a nature that an artificial nose has to be made at the same time, the lip becomes a part of the appliance that is to fill in the deficiency and to restore the form of the missing tissue. It should be constructed of hard vulcanite, colored by painting to imitate the natural tissue, or—as is most commonly done for male patients—as much covered by an artificial mustache as possible. Owing to the fact that the natural lip is a very mobile structure, a lip constructed of hard vulcanite does not have a very natural appearance, however well its surface may imitate the appearance of the skin and mucous membrane. The general plan, then, of covering it up with an artificial mustache or beard (for male patients) is to be applied as frequently as possible. The immobility of the artificial lip is also a serious drawback to its functional efficiency, but, when the other lip is intact, it serves to restrain the food and saliva.

The other manner of affording a suitable support for an artificial lip is to attach it to an artificial denture, and several cases have been reported in which this has been done. Experience has established the principle that the lip should fit close to, or be continuous with, the outer surface of the plate, for, if a space were left here, it would become filled with food which the tongue could not remove. Land[*] has described a case in which he restored a portion of the lower lip by attaching the artificial substitute to a full lower denture, the whole being executed in porcelain upon platinum and the external portion of the lip bearing a mass of hair to blend with that of the beard. In another case Jori[†] attached an upper lip of platinum, covered with jeweller's enamel, to a partial upper plate.

Martin[‡] has suggested the use of lips of soft rubber, made hollow and very thin and filled with water after the manner of the artificial tongue of his construction presently to be described. (See page 29.) This would seem to offer great possibilities in the way of natural appearance and functional efficiency.

3. **Artificial Ears.**—In the construction of artificial ears one has only two things to consider—the appearance presented by the artificial substitute and the means of attaching it firmly in its place. The materials of which they are composed are celluloid, porcelain, and hard rubber or vulcanite. Celluloid, when not exposed to the mucous secretions of the mouth nor to the moisture condensed from the breath, wears very well and is recommended by Kingsley because of the natural appearance which may be obtained by its use. Porcelain is very heavy and it is very difficult to construct an ear of this material because of the complexity of the form. Vulcanite colored with oil paints is light enough and otherwise satisfactory; it is the material most commonly used.

The lost portion of the ear is modelled in wax after an impression of the remnant has been taken and a cast made; or, if the ear is entirely missing, it will be necessary to make a complete model in wax. This is then reproduced in whatever material is selected for use.

The means of attachment depend upon the conditions that exist in each case. Usually the external auditory meatus affords lodgment for a tube of gold or for flat springs of that metal, the latter serving chiefly to keep the artificial ear in position and not to support it. In a case described by Martin a portion of the lobule remained. A hole was pierced through this as is done for ear rings, and into this hole was introduced a small gold wire, to serve as an accessory support. The chief weight of the artificial ear should be borne by a delicate metallic spring in the form of a band which reaches over the top of the head and is hidden in the hair.

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[*] The Dental Cosmos, vol. xl., p. 1003.

[†] Le Laboratoire, August, 1905, p. 661.

[‡] "De la Prothèse Bucco-Faciale et du Squelette," p. 42.

4. **Restoration of Parts of the Face.**—The cases which require restoration of certain portions of the face (other than those already described elsewhere in this article) are so varied that it is manifestly impossible to classify them. We shall consider here more especially those cases in which the loss of substance involves the cheek or the orbital region. (The placing of artificial eyes will, of course, not be discussed, as this forms a special branch of prosthesis by itself. (See Vol. V.)

The general indications to be followed in this method of restoration are: to fill in the cavity with an appliance that shall completely occupy it, save where channels—as, for instance, for the passage of the air current—are necessary; to use materials (hard vulcanite, preferably) which are unchanged in contact with mucous or skin surfaces and which are innocuous; to provide for the appliance a support which shall be as light as possible and which shall be supported upon firm healthy tissue; to restore the external contour and appearance of the missing part; to provide for the easy removal of the appliance; and, finally, to give to the latter a smooth surface without recesses, in order that it may be easily cleansed. Perhaps the importance of these indications may be emphasized by a brief reference to a few reported cases.

Hinman* describes a case in which an epithelioma had caused the loss of the following parts on one side of the face: Superior maxilla, malar bone, nasal bone, eye, a large portion of the cheek, and a part of the nose. Several years having elapsed since an operation for the removal of the growth had been performed, and the surrounding parts furnishing no evidence of its return, Hinman constructed, out of aluminum, an appliance that was intended to supply in some degree the lost parts. This appliance, which was hollow, was covered externally with vulcanite and then painted to match the skin. It was sustained in place partly by the support of the walls of the cavity into which it fitted and partly by means of a band that was passed around the head and so arranged as to appear to support a patch placed over the orbit. This device effectively hid the empty orbit and the line of juncture of the appliance and the skin. Its lower border was hidden by a portion of an artificial mustache and beard which was attached to the appliance and blended with the natural beard on the face.

Hayman† made an appliance for a somewhat similar case. In this instance vulcanite was used as the material of restoration, and an artificial eye was inserted in the orbital cavity.

Martin‡ constructed an appliance which resembled in many respects that last described. He, too, employed vulcanite for the material and inserted an artificial eye. This appliance was merely an external shell and was supported in place by a three-pronged projection of rubber which, by contact with the walls of the cavity at suitable places, held the substitute in place. Martin has suggested the use of soft rubber, as an acceptable addition to some of these appliances, at places in which they are in contact with mucous membrane.

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* The Dental Cosmos, vol. xxxviii., p. 559.

† The Dental Cosmos, vol. xxxi., p. 404.

‡ "De la Prothèse Immédiate, Restauration de la Face," p. 279.

5. **Artificial Tongue.**—The results which follow complete or partial removal of the tongue by amputation are so serious that various attempts have been made to remedy these defects by the use of an artificial appliance. The extreme mobility of the tongue, in consequence of its complicated musculature, renders it very difficult to reproduce, in an appliance, anything like the active function of this organ. Furthermore, the fact that, after the removal of this organ, the surrounding muscular structures can impart little motion to an artificial substitute, makes any such appliance relatively very inefficient. Nevertheless, in some cases the use of a prosthetic substitute ameliorates the condition of the patient and adds not a little to his comfort. It is also well to remember that, in some instances, the reparative activities of Nature often accomplish more toward compensating for the loss of the tongue than the ingenuity of man can possibly effect.

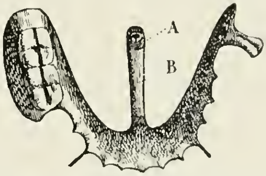

Fig. 26.—Lower Plate to Support Artificial Tongue. *A*, Ring to which tongue is attached; *B*, flexible projection from plate. (Martin.)

The large part played by the tongue in speech is appreciated when this organ has been removed and the patient is unable to enunciate distinctly any of the consonant sounds. Furthermore, without the tongue the patient is unable to roll the food from side to side and to keep it between the teeth during mastication. Food collects about the teeth, and, unless it is carefully removed after each meal, it ferments and the mouth soon presents a most unhygienic condition.

Ambroise Paré, Delabarre, and others have tried to bridge over the floor of the mouth with an appliance which, while accomplishing no other purpose, would cause the food to slide between the teeth. Martin* has applied an artificial tongue in three cases. The construction of this appliance is most ingenious, and it appears to have greatly alleviated the inconvenience of the patients. "The apparatus is composed of two pieces: The first (Fig. 26) is only a dental plate serving for the support of the second, which replaces the missing tongue. The first piece is constructed of hard vulcanite moulded to fit exactly the inner surface of the whole lower dental arch. . . . At the median line and upon the internal face of this piece is affixed an extension of vulcanite slightly flexible (*B*). It carries at its extremity a ring (*A*) to which is to be attached the second part of the appliance—that is to say, the artificial tongue.

"This extension is to fit into the groove (*C*) of Fig. 27. At the end of this is placed a ring (*B*) which serves to close the opening by which the liquid is introduced and which attaches it to that of the artificial denture.

"The extension of this last should be more or less long, according as would be necessary to fix the tongue at a point anterior or posterior. It should serve, on the other hand, to elevate the anterior part of the tongue to aid in the pronunciation of the linguals. In this case, it will serve as a spring, and ought for this effect to be very thin and very flexible. In this way, the tongue, although remaining very mobile, is solidly maintained.

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* "De la Prothèse Immédiate," pp. 373–375.

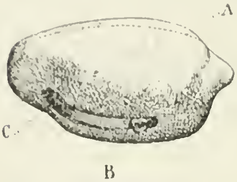

Fig. 27.—Artificial Tongue, Consisting of Rubber Bag Filled with Water. *B*, Ring for attachment to projection of lower plate. *C*, groove for lodgment of projection to which tongue is attached. (Martin.)

"The tongue consists of a bag of very soft rubber; it is incompletely distended with water or an antiseptic liquid; it has the form and dimensions of the missing tongue. On its upper surface it presents a thickness of one millimetre, which is reduced to a half or a quarter of a millimetre at its lower and posterior portion. This lesser thickness of its under surface permits it to mould itself, as it were, to the floor of the mouth, and to be obedient to the movements which are imparted to this by the subhyoid muscles. By this means the movements are transmitted to the whole apparatus, and even permit the patient to protrude the tongue out of the buccal cavity. In Fig. 28 we see the two parts united."

The artificial tongue devised by Terrell * was attached to a lower plate of metal that fitted around the inner surfaces of the teeth of the lower jaw. This plate was held in place by a round wire extending transversely across the floor of the mouth from the last molar on one side to the last on the other. The author says concerning this plate: "My next and last experiment was to take the outer rim which I had swaged, and, as it was very irregular on account of its following the lines of the teeth, I tacked against it with solder a strip of thin platinum plate, making a perpendicular walled box on the inside. I then filled in the space between these two pieces with solder, making a rim of solid metal with the top edge even with the top of the teeth. I now modelled out of modelling compound a tongue to fit inside this walled rim, with a thin flange projecting from the tongue and resting all around the top edge of the rim. I made it nearly flat on top, and toward the back I made a gully as a sort of director for guiding the food into the œsophagus. The back end of the tongue was made thick and bevelled under so as to fit the stump. The compound was moulded around the wire in the back so that any movement of the stump would impart motion to the artificial tongue, causing the end to tip up. After getting the proper shape of a tongue in modelling compound, I duplicated it in block tin which I found to be too heavy. It was so heavy that it tired the patient's stump of tongue. I then made one of red vulcanite, weighting it near the back end. The last thing was to attach two molars to the rim on the

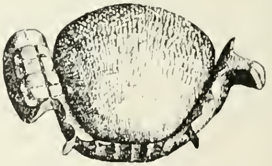

Fig. 28.—Artificial Tongue Attached to Supporting Plate. (Martin.)

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* The Dental Cosmos, vol. xlii., p. 330.

right side to replace two of the patient's own that had been lost, and the artificial tongue was completed."

6. **Artificial Larynx.**—The problem of replacing a larynx by artificial means, after its ablation, has been fraught with many difficulties since Billroth first practised the removal of this structure. The difficulties have been, not so much those attending the mechanical construction of a satisfactory sounding-box, as those which are connected with the introduction and removal of the appliance and the necessity of keeping the food and secretions out of it. The mechanism, being necessarily of a somewhat delicate construction, must be kept clean and free from foreign matter; and, if the appliance is to occupy the former position of the larynx, some special provision must be made to exclude the food both from it and from the respiratory tract, all power of doing this in a natural manner having, of course, been destroyed with the removal of the larynx.

Gussenbauer's larynx was in the form of a connecting tube that extended to the tracheal cannula, at the upper end of which tube were placed two very thin strips of metal which were made to vibrate by the air, thus representing the vocal cords. During a meal the food was excluded by means of a stopper in the lower end of the appliance. von Bruns improved upon the appliance by substituting, for the lower end of the unyielding tracheal tube, one made in sections and flexible, which permitted the movements of the pharynx and the neck, and he replaced the metal vocal cords with some of rubber which gave a less harsh sound. Wolff still further improved this by adding a metal grating over the upper opening of the appliance to prevent the ingress of food and secretions; but even with this it was necessary to have the stopper below in place during the meal.

Martin * has described an appliance in which the entrance of food into the trachea is effectively prevented. According to his plan a soft-rubber reproduction of the general form of the removed organ is inserted at the time of the operation, and is allowed to remain in place during the healing of the wound, thus preserving the channel between the trachea and the pharynx. The appliance consists of a tracheal cannula to the top of which is fitted the larynx itself. This latter consists of three parts:—(*a*) A resonating chamber having a little less volume than the larynx, and closed at its upper opening by a metal grille of fine mesh designed to prevent the entrance of solid particles of food. (*b*) A metallic tube, rectangular in cross section, occupying the centre of the resonating chamber. Across the top of this is stretched thin rubber, which exhibits a transverse slit 25 mm. long. This slit permits the expired air to escape, and this current of air thereupon sets the edges of the slit in vibration. Valves on the front and back surfaces of this tube permit inspiration, but, being closed during expiration, the air is forced through the slit above referred to. (*c*) An œsophageal tube, which is attached to the posterior wall of the resonating chamber and, descending, enters the œsophagus. This has at its lower extremity a valve which, while it permits fluids to enter the œsophagus, closes and prevents regurgitation from the latter into the appliance. The purpose of this tube is to drain the resonating chamber of secretions or fluids which find their way into it, the rubber lips of the larynx proper being in contact except during expiration and effectively preventing the entrance of these fluids into the trachea.

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* "Sur les Larynx Artificiels," L'Odontologie, October 15th, 1902.

Hochenegg and d'Aubry have constructed appliances for speech in which the motive power came from a bulb pressed by the hand or against the chest; and others have improved upon these designs in some degree, but the contrivances have never been extensively used.

The most ingenious artificial glottis thus far devised is that of Delair,* which is different in principle from any before described. It has the advantage of being attached to a dental plate and occupying a position in the mouth near the posterior pharyngeal wall. Consequently it can be used in cases of laryngectomy in which the communication between the trachea and the mouth has not been preserved; and, besides, its insertion does not call for a new operation for the purpose. It is also possible for the patient to eat, drink, speak, and breathe without removing the appliance and without incurring the danger that particles of food may find an entrance. Furthermore, it is very readily removable for purposes of cleanliness.

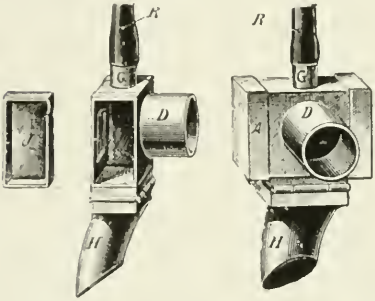

Fig. 29. Side and Back Views of the Silver Tracheal Box. (Delair.)

In solving the difficulties which he met in preparing the larynx for the first case of this sort which came under his observation, Delair thought of the expedient of using the principle of the ordinary bird-call employed by fowlers. It is possible to vary the tone emitted by this bird-call by varying the tension with which the lips of the appliance are stretched or by varying their length, and thus to render the voice tones suitable to the sex or age of the patient. Delair has described a case in which the patient, in order to hide the rubber tube which enters the mouth, was accustomed, when out walking, to hold it in the corner of his mouth with his left hand. The appliance has successfully been used in six cases.

The following is the author's description of his instrument:—

"The apparatus is composed of three elements: An external portion—the box containing the tracheal valve; two intra-oral—the palatal portion and the artificial glottis. (See Figs. 29 to 35.) (*a*) The box containing the tracheal valve is of fine silver (see Fig. 29); it is rectangular and closed hermetically by a valve of very thin rubber; on its posterior side is soldered a tube (*D*) 13 mm. in diameter, exactly fitting the tracheal cannula that permits the entrance of air into the lungs; in front—that is to say, on the anterior wall—is situated a rectangular opening (*E*) behind which is stretched a curtain, the rubber valve (*F*); through this opening the air enters the box, and thence the trachea; the top part ends in a cylindrical tube (*G*) 7 mm. in diameter, for the departure and entrance of the air into the palatal portion; at the bottom of the box there is a little rectangular door upon a hinge (*H*) to facilitate cleansing; finally, two other lateral doors, that permit the introduction of the valve and its support (*J*) and also the screwing of two retaining bolts.

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* Léon Delair: "Larynx et Glotte Artificiels." Le Laboratoire, Nov. 1st, 1904, p. 46.

"It is easy to understand the functioning of this apparatus. At each inspiration the air raises the valve hung vertically at the front of the box, and enters the trachea and the lungs; during expiration the valve, pushed back by the air, closes hermetically the anterior opening, and the air makes its exit by the upper tube. From this part a rubber tube (*R*), 5 mm. in diameter, which curves around the chin, passes through the beard and enters the mouth through the commissure of the lips, where its termination joins the palatal portion of the apparatus.

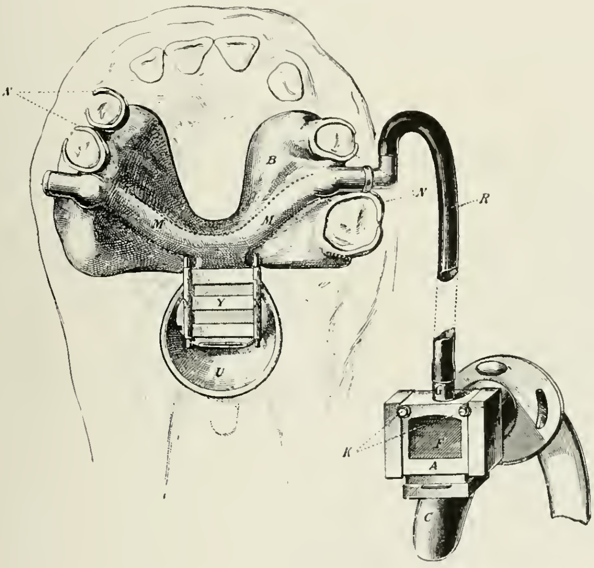

Fig. 30.—General View of the Assembled Appliance. (Delair.)

"(*b*) The palatal appliance is of gold. (See Fig. 30.) It is formed of two plates, 15 mm. wide, soldered together at their borders. Between these two plates is left a space, 8 mm. in width; at the centre of this space the plates are separated about 2 mm., being united together at their borders. There is in the centre a sort of fusiform tube, much flattened in order to give the tongue the minimum of inconvenience. This channel to admit the tube is placed transversely across the palatal vault immediately in front of the aponeurotic portion of the velum. The piece is maintained in place by four gold clamps soldered to the plate: on the right side they rest upon the remaining bicuspids (*N*), on the left on the second bicuspid and the first molar. On each side the sixth-year molar is missing. These two spaces are utilized for the passage of the two extremities of the hollow apparatus, which end in cylinders at the level of the buccal face of the adjoining teeth, and which present screw sockets 6 mm. long and 5 mm. in diameter. In one of these sockets is screwed an elbow of metal (*P*) 1 cm. long. (See Fig. 31.) It is to this elbow, attached by means of the screw thread, that the extremity of the inlet air tube is joined. At the posterior part of the appliance an oval opening, 10 mm. long by 5 mm. wide, is arranged for the exit of the breath. It is easy to see, then, that the expired air, driven back through the tube in the hollow plate, makes its exit under pressure at this little opening.

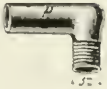

FIG. 31.—The Metal Elbow for the Attachment of Rubber Tube Leading from the Tracheal Box. (Delair.)

"(*c*) It is to this oval opening that the rubber bird-call is fixed. (See Fig. 32.) This bird-call consists of a frame in the form of a thin crescent of gold (*Q*); this is enveloped by a truncated pyramid of rubber tubing extremely thin. At the posterior part is soldered an oval tube, about 4 mm. long and 9 mm. in diameter, to fit in the corresponding opening left in the back of the palatal piece (*S*). The bird-call is 22 mm. wide and 20 mm. long. The two branches of the frame distend the rubber bird-call, the two lips of which are closely approximated, and the rubber tube is elsewhere complete.

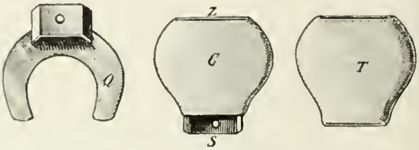

FIG. 32.—Metal Frame (*Q*), Rubber Bird-call (*T*), and Frame Distending Bird-call (*C*). The air is forced in at *S* and the lips (*Z*) are set in vibration, thus causing the sound. (Delair.)

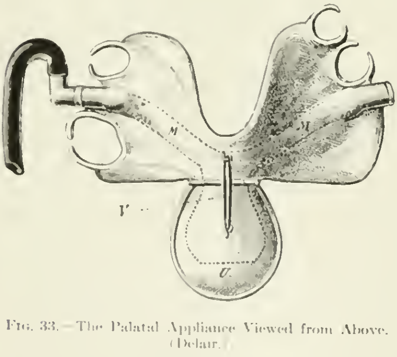

FIG. 33.—The Palatal Appliance Viewed from Above. (Delair.)

"As the expired air is projected into the apparatus by the patient with more or less force, according to the tone which he desires to give to his word, the two lamellæ of rubber are more or less distended from their base to their extremity, and their borders, acting as a veritable glottis, are put in vibration by the passage of air, which in turn is set in vibration. This phenomenon is produced at the centre of the end of the velum of the palate, immediately in front of the uvula. The opening of the bird-call is therefore placed obliquely at the back of the velum of the palate. Thus the sound produced is projected in the direction of the pharynx, and, according to the articulated sound to be produced, it is directed either toward the cavity of nasal resonance or toward the mouth, where the secondary organs of speech transform it into words. Furthermore, the lips of the glottis, being closely approximated, prevent the entrance of food into the bird-call during deglutition, and this permits the subject to speak and to eat without removing the instrument.

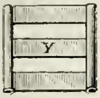

FIG. 34. — Metal Framework which Prevents Contact of Tongue with the Rubber Glottis. (Delair.)

"However, this appliance, very simple in principle, would have functionated very imperfectly if it had not been supplied with an indispensable improvement. We know that during the emission of about four-fifths of articulated sounds the palatal velum is raised and is applied to the posterior wall of the pharynx, forming thus a partition between the mouth and the nasal fossæ. During this physiological phenomenon the bird-call is situated between the tongue, the pharynx, and the velum. The artificial glottis, in this instance, can then vibrate without hindrance. It is not the same, on the other hand, when the simple sounds and the nasally articulated sounds are produced, as in this case the velum of the palate is depressed in order to permit the column of expired air to vibrate freely in the two resonating chambers, the mouth and the nose. At this time the bird-call, during the emission of these last two sounds, is found to be compressed simultaneously by the velum of the palate and by the tongue. A special provision, imitated from my appliance for the velum of an artificial palate, avoids the contact with the velum of the palate against which it is applied. This is a thin plate around the edge of which is soldered a round wire in order to render its contact more agreeable to the mucous membrane. A little rubber band (*V*) permits the movements of elevation and depression in accordance with those of the velum (*U*). This protector is 2 mm. wider than the bird-call. Underneath this, two parallel stems (*X*), screwed into the palatal appliance, support a little framework of metal (*Y*), which prevents the tongue from coming in contact with the end of the bird-call—that is to say, the artificial glottis (*Z*)."

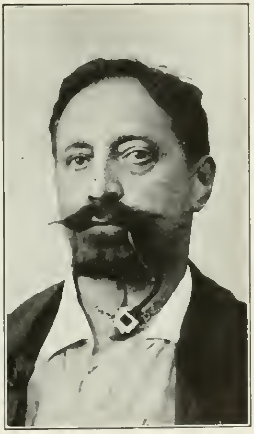

FIG. 35.—Patient with the Appliance in Place. (Delair.)

IV. PROSTHESIS AFTER RESECTION OF THE JAWS.

When a resection of either the upper or the lower jaw is contemplated by the surgeon, in the treatment of necrosis or tumors or in connection with gunshot wounds or other traumata, he is always embarrassed at the thought of the sequelæ of the operation, which are usually most serious.

A review of those sequelæ which immediately follow the resection of the mandible gives, first, a recession of the tongue into the throat. This occurrence may be embarrassing at the time of the division of the attachments of the tongue to the anterior portion of the mandible, or it may become so later, when the organ is no longer held in place by a ligature passed through its substance. Such a falling back of the tongue embarrasses both respiration and deglutition. In rare instances in which the attachments of the organ have not been disturbed, the resection of the mandible having taken place on one side of the symphysis, the protrusion of the tongue through the mouth may be the embarrassing feature. Among the other well-known sequelæ may be mentioned impairment of mastication, difficulty in speech and deglutition, dribbling of the saliva, and the deformity of the face incident to the resection.

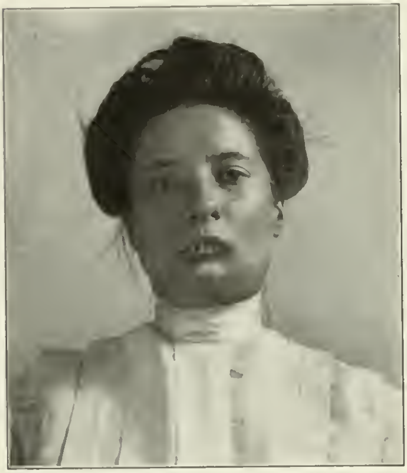

FIG. 36.—Patient for Whom a Resection of the Right Half of the Mandible Has Been Done. The picture shows deviation and retraction of the chin.

The secondary results are largely due to the contraction of the cicatrix, and include an increase in the deformity due to an approximation of the ends of the remaining portions of the bone. This is expressed as a retraction of the lower side of the face and a deviation of the chin and the buccal orifice. (Figs. 36, 37, 38.) In the mouth the upper and lower teeth are no longer in occlusion, and as a result proper mastication is impossible. (Fig. 39.) Instead, the teeth come into contact with the soft tissues, with the resulting abrasion and ulceration incident thereto. Satisfactory speech is wellnigh impossible, and, in rare cases, the tongue, being no longer retained in the mouth, protrudes between the two resected portions of the jaw. Finally, from the lack of proper occlusion we have a deformity of the palatal vault and of the arch of the upper teeth.

The recession of the tongue and the approach of the two fragments of the mandible are the two things which it is most desirable to avoid.

Claude Martin,* in 1878, first conceived the idea of an immediate prosthesis in cases of resection of the jaw, and he then proposed the method which, with slight change, he uses at the present time. The method has not come into general use in this country, but it has been employed successfully by its author during the past thirty years, and the results which he has reported amply justify the utilization of this procedure in the cases which are now under consideration. The rationale of the method is as follows: Following the resection of a portion of the maxilla or the mandible, a previously constructed appliance, made of hard rubber and corresponding in shape to the removed section of the bone, but of slightly larger dimensions, is inserted into the wound. It is attached firmly to the remaining portions of the bone by means of screws and bands of metal, or to the remaining teeth by clasps. The external wound is sewed up; the internal wound is left open, communicating with the oral cavity. The prosthetic piece is riddled with channels which stand in communication with a soft-rubber tube that enters at either corner of the mouth. This is for the purpose of making frequent lavage of the wound with antiseptic washes under high pressure. After the wound has healed, the temporary appliance is replaced by one of slightly smaller volume and without the irrigation canals, and this is destined to be permanent, except that it is removable for purposes of cleansing.

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* Claude Martin: "De la Prothèse immédiate appliquée à la Résection des Maxillaires."

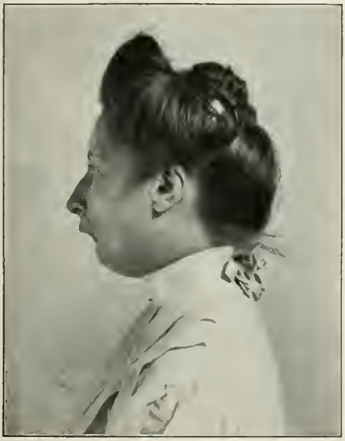

Fig. 37.

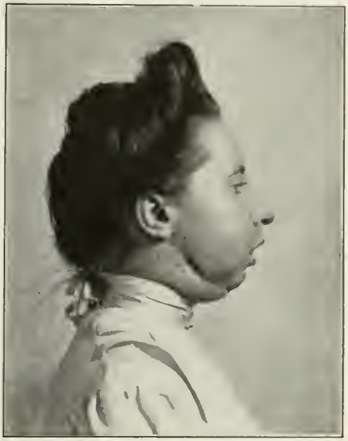

Fig. 38.

Fig. 37.—Profile View of Patient Shown in Fig. 36. Note the retraction of the chin.
Fig. 38.—Profile View of Patient Shown in Fig. 36. Note the retraction of the scar.

It is an unusual procedure to place a foreign body in an open wound, and especially one communicating with a cavity so full of germ life as the mouth, but the system of frequent lavage with antiseptic solutions under pressure has rendered this objection of less moment than would appear theoretically to be the case.

It has been objected that the lavage, which is instituted every few hours and which is begun immediately after the operation, washes away the blood-clots and thus produces hemorrhage. Martin's experience has been contrary to this, and he says that the lavage does not interfere with hæmostasis, and that, by preventing infection, it thus prevents secondary hemorrhage.

Another objection which has been offered is that, owing to the fact that the ends of the bone are bathed in the fluids of the mouth, they become infected and suppurate; that then the appliance becomes movable by reason of a loosening of the screws and that in some cases it must be removed; and that, when this is done, the resulting contraction of cicatricial tissue is exactly as great as if the appliance had not been inserted. While it is true that this may happen, yet careful lavage succeeds in preventing such a result in a great majority of cases. It is undoubtedly true that the presence of the temporary appliance, by keeping up suppuration of the wound, is responsible for the long time required in some instances for the wound surface to become covered with epithelium, which change must take place before the permanent appliance can be put in position. Martin has found that, in favorable cases, about one month is required for the completion of this process, while in some cases he has been obliged to retain the temporary agent for as long a period as eighteen months. Francisque Martin,* the son of Claude Martin, and collaborator with him in the work, has given the following answer to the other objections raised against the method:—

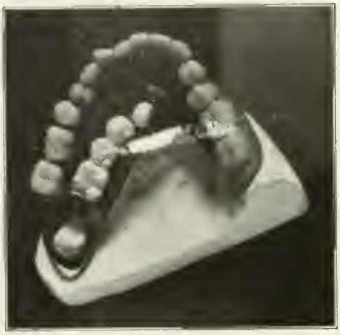

FIG. 39.—Artificial Lower Denture Fitted to Teeth of Left Half of Mandible of Patient shown in Fig. 36. The artificial teeth occupy approximately the position of the former natural teeth shown on the cast, having been arranged to occlude with the upper teeth, from which may be judged the amount of retraction of this side of the mandible from cicatricial contraction.

"Before concluding I wish to discuss, and to refute before you, the principal objections that have been raised against immediate prosthesis. These are principally two: viz., first, that it favors the infection of the wound; second, that later on it becomes the cause of a relapse.

"The first of these objections was made twelve years ago by Boennecker. 'The piece of rubber,' says the German author, 'that covers the soft and bony sectioned parts does not allow a free discharge of the secretions, and one cannot be sure of the asepsis of the apparatus. In the prosthesis of Dr. Martin a backward step is made as regards the treatment of the wound. . . . He places a foreign body which promotes retention, and hence, the disinfection of the mouth being impossible, it is a serious fault against antisepsis.'

"As Claude Martin replied long ago, these objections are entirely theoretical, and appear to be puerile to those who see us daily practising our method. Let us, however, discuss them in order to enlighten the members of the congress upon the important question.

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* "Immediate Prosthesis in Maxillary Resections: Method of Claude Martin of Lyons." Transactions Fourth International Dental Congress, vol. iii., p. 194.

"The disinfection of the buccal cavity is quite possible, and even quite easy to effect, if the rules we have laid down be carried out. The question of the antisepsis of the mouth after operations followed by prosthesis has always been Claude Martin's desideratum. 'It is for this reason,' he writes, 'that we have in our prosthetic pieces hollowed out canals of irrigation opening on to all points of the cruentous surface and through which it is easy to make antiseptic washings.' We are so convinced of the efficiency of the means we have adopted that we do not hesitate to make the washings ourselves in the hospital wards when the temperature of the patients rises, to prove that with a little care a complete disinfection can be effected and a stop put at once to the faults of retention.

"Boennecker, continuing his remarks, calls attention to the fact that we mention in our observations a case of erysipelas and another case in which there was a particular fetidity of the mouth. It suffices to reply that the complications referred to by Boennecker took place in 1878, a period when antisepsis was in quite a rudimentary stage, and when we had not yet made use of our apparatus fitted with irrigation canals. We think, indeed we are certain, that in taking as a basis our practice of the last twenty years, and with our apparatus facilitating the washing out of the parts, every infectious accident should disappear, especially if care be taken to make, as we recommend, irrigations of the buccal cavity under high pressure. From this point of view, we cannot insist upon it too strongly. Esmarch washings must be absolutely given up. This manner of irrigation, which we too often see employed by ill-trained hospital attendants, does not give sufficient pressure. Eguisier's irrigator must infallibly be used, which gives a pressure of 75 metres. In frequent washings under high pressure lies the whole secret of success.

"We now come to the question of a relapse of the disease after immediate prosthesis. Immediate prosthesis has often been incriminated, and even is to-day by some surgeons, as inducing a relapse. This opinion is based, we think, much less on an examination of facts than on a generally admitted idea that the causes of mechanical irritation are also the causes of tumors. This idea of general pathology is correct, but, in the particular case referred to, an ill-judged application of it was made. In fact, the prosthetic apparatus, solidly fastened, cannot be compared to a mobile foreign body, which, by its frequent change of place, is necessarily a cause of irritation. Although the fixing arrangement described above has only been presented a short time relatively, my father nevertheless had already made use of it for a considerable time before, and I hasten to describe it to you, being convinced that henceforth such a reproach can no longer be laid to the charge of immediate prosthesis.

"A strict examination of facts, in the numerous observations that my father possesses, some of which date as far back as twenty-five years (see the publication mentioned above), refutes entirely such an objection. Moreover, we do not hesitate to say that immediate prosthesis offers, on the contrary, a guarantee against a relapse. In fact, the prosthetic apparatus, whatever its size may be, is just as easy to fix; consequently the surgeon, when he has recourse to immediate prosthesis, is more at ease in making a large ablation of the tumor, which indeed is the principal guarantee against a recurrence."

Martin has a very ingenious method of constructing his appliance for immediate prosthesis for the lower jaw. This is done some days previous to the operation. An impression is taken of both the upper and the lower jaw in the mouth and plaster casts are made from these; at the same time the height of the lower jaw from the chin to the top of the teeth is measured. With these data as guides a natural mandible is selected as nearly of a size with the one to be resected as possible. This is reproduced in wax by the use of a plaster piece-mould made over the natural mandible selected.

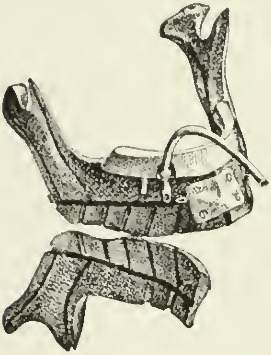

FIG. 40. — Temporary Appliance of Vulcanite for Immediate Prosthesis of Resected Mandible. The figure shows irrigation channels and tube, and method of uniting the two halves of the appliance. (Martin.)

The inner surface of the mould having been oiled, the melted wax is poured in, and after it has hardened it may be easily removed. The shape of the wax jaw may be changed by bending if comparison with that of the patient makes it necessary. This is reproduced in black vulcanite, vulcanized at a temperature of 145° C. for three hours. In order to provide for the irrigation channels, a zinc tube is placed in the portion corresponding to the body of the bone and two in the ascending ramus, and these are filled with Spanish white. The zinc tubes are subsequently removed by immersing the piece in dilute hydrochloric acid for two or three days. Supplementary channels leading from this to the lower border of the piece are made by drilling into the tube from this border. (Fig. 40.)

If both sides of the jaw are to be resected, the vulcanite piece is divided at its centre and provision is made for the reuniting of the two halves by means of a metal plate screwed to its outer surface. At a position nearly corresponding to the corner of the mouth, an entrance is made into the main irrigation channel for a soft-rubber tube which is affixed to this opening and which transmits the antiseptic solutions used for lavage.

Another means of uniting the two halves of the divided appliance consists in a horseshoe-shaped piece made of hard rubber and intended to come in contact with the arch of the upper teeth. On each side of this, underneath, there is a projecting stem of metal which fits into a socket in the vulcanite. This serves both to bind the two halves together and also to provide a surface of contact to the teeth of the upper jaw.

While it is not necessary to construct a complete jaw for each case to be resected, it is wise to err on the side of having too much rather than too little. This prevents any embarrassment that might arise at the time of operation because the surgeon found it necessary to cut farther than he at first intended in order to obtain sound tissue. It is a very simple matter to trim the vulcanite jaw until it has the size required for restoring the resected part. It is advisable for the surgeon to cut the bone, if he is dealing with the body of the jaw, in such a manner that the cut surface shall slant downward and forward. This facilitates the immobilization of the prosthetic appliance and renders the successful use of the permanent fixture a greater probability.

The absolute fixation of the prosthetic appliance is necessary. The method pursued by Martin is to have a broad projecting metallic plate on the inner surface passing to the inner side of the remaining fragment of bone. On the outer surface are placed two narrow metallic strips, each united to the prosthetic appliance by a screw. These are crossed and their outer ends are similarly united to the bone by a screw driven into its substance. This mechanical arrangement perfectly immobilizes the fixture. (Fig. 41.)

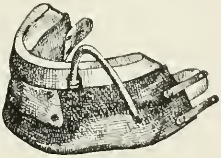

Fig. 41. — Temporary Appliance of Vulcanite for Immediate Prosthesis of Resected Mandible. Prepared for insertion and attachment to the remaining fragments of bone. (Martin.)

The external wound is then sewed up and should, except in rare cases, heal by first intention. If the tongue shows a tendency to fall back, a ligature may be passed through its frenum and made fast either to the appliance or to the soft tissues.

The healing of the wound is of course delayed by the presence of this foreign body, but it is only delayed, and will eventually take place. Its healing will be further delayed unless the septic products found in the wound are frequently removed by a lavage with antiseptic solutions. Martin recommends that at first this be done as often as every two hours, and he insists upon its being done with sufficient pressure thoroughly to cleanse the wound. The formation of an epithelial lining in the pocket that contains the vulcanite fixture is dependent upon this preservation of the wound from prolonged suppuration.

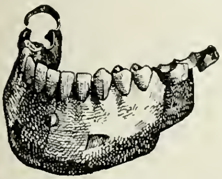

Fig. 42. — Permanent Appliance of Vulcanite for Use in Resection of the Mandible After the Temporary Appliance is Removed. The figure shows means of attachment to teeth and means of preventing movement of remaining bony fragments by contraction of the scar tissue. (Martin.)

When the parts have completely healed the lavage may cease and the temporary fixture may be replaced with a permanent appliance.

The following is the technique usually followed by Claude Martin:—"Before changing the apparatus we take an impression of the mouth of the patient, of the remaining fragment or fragments, and of the upper edge of the temporary apparatus. We cast this impression, and then construct an apparatus in such a way that it will have, by means of clasps and laminæ, a solid hold on the teeth of the remaining fragment; and at the point where the dental arch of this piece corresponds to the temporary apparatus there is a groove into which the ridge of the apparatus fits. As soon as the temporary apparatus is removed we place it in that groove and fix it there with two or three screws. Add the time required for adjusting all this apparatus on the model of the remaining fragment that we obtained by the first impression, and for placing the model apparatus in plaster, and the time the latter takes to set, and all is finished. The few minutes consumed in this operation will certainly not be sufficient to allow the cicatricial bands to draw the bony fragments nearer together, for, as soon as the plaster is hard, the impression is removed and the original appliance, the canals of which have been stopped with hard wax, is replaced in the mouth of the patient in the same manner as is an ordinary set of artificial teeth. This gives ample time in which to construct a permanent appliance. If the temporary appliance is put in its proper place in the impression, and a plaster cast is poured, a cast is obtained which reproduces the teeth and gums correctly, and when the temporary appliance has been removed it leaves a groove representing the groove in the soft tissues into which it fits. Upon this cast there may be constructed a permanent appliance which will have the exact form of the temporary appliance." The permanent appliance is made of hard rubber and is removable for purposes of cleanliness. (Fig. 42.)

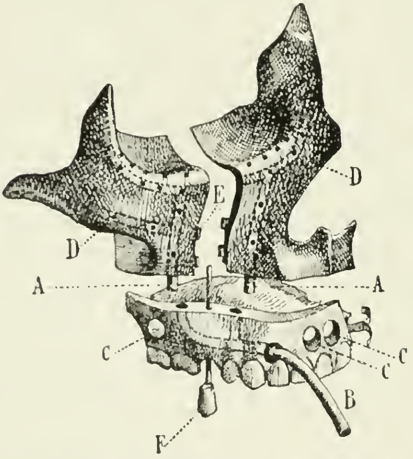

Fig. 43.—Temporary Appliance for Use in Immediate Prosthesis Following Resections of the Maxilla. The figure shows its three portions and the means of uniting them. *A*, *A*, Tubes serving for irrigation channels and also as dowels to unite the two upper portions to the lower; *B*, irrigation tube; *C*, *C*, *C*, openings to permit escape of antiseptic washes used for lavage; *D*, *D*, external openings permitting the antiseptic washes to be conveyed to the wound surfaces; *E*, metallic tubes; *F*, crown with long pin attached passing through tubes (*E*) to unite appliance. (Martin.)

Immediate Prosthesis in Resections of the Maxilla.—The sequelæ which occur after resection of the maxilla are somewhat similar to those which follow resection of the mandible, although they are not so serious. Because of the loss of the skeletal support, the soft tissues fall inward, causing a deformity which is further aggravated by the subsequent cicatricial contraction. Bichat and Ollier (quoted by Martin) have found that the surrounding bony parts show a tendency to be drawn together, thus reducing the size of the cavity caused by the resection. As a result of this contraction the orbital tissues are pulled inward and downward, with a consequent lowering of the eye on the affected side; and in addition, the drawing of the sound maxilla into the cavity causes the remaining upper teeth to be displaced to such an extent that they no longer oppose those of the mandible. Martin's appliance tends to prevent these deformities and at the same time permits the patient to eat and speak shortly after the operation—a consideration of no little importance. Owing to the fact that it is placed between the malar bone and the sound maxilla, the appliance serves to hold these structures apart and in this way it opposes the contraction to which reference has just been made. Besides, the upward pressure exerted upon the appliance by the teeth of the lower jaw aids materially in supporting the floor of the orbit. I am informed by Dr. Joseph D. Bryant that he has observed, in instances in which the floor of the orbit was not removed, most satisfactory results from the introduction of a simple plate which fits what remains of the bony roof of the mouth and extends outward in such a manner as to hold the cheek in place. The stability of this plate is much increased if no teeth are attached.

The Temporary Appliance. — The temporary appliance consists of two portions: one corresponding to and restoring the palatal vault, and the other representing only the anterior face of the resected bones. To facilitate its introduction and removal the appliance is divided into three sections, which are united together by means of a connecting pin, as shown in Fig. 43. The vertical portion represents the face of the maxilla, the malar bone, the nasal bone, and the floor of the orbit. It is made entirely of hard rubber and is provided with irrigation channels, as shown in Fig. 44. It is very important that these latter should be numerous and close together. The portion corresponding to the dental arch and the vault of the palate is also made of hard rubber, and in it are set teeth so arranged as accurately to articulate with those of the lower jaw. The palatal portion extends to the other side of the vault, fitting around the necks of the natural teeth and attached to them with clasps which maintain the apparatus in place. If there are no teeth in the superior maxilla, support is secured by means of a spring which is attached to the teeth of the lower jaw. The posterior part of the palatal portion is of soft rubber in order to give free play to the remnant of the velum and to permit the closure of the passage into the nasal chambers. The tube connecting with the irrigation channels is attached in front over the canine tooth, and two openings in the centre of the horizontal portion permit the antiseptic washes to escape.

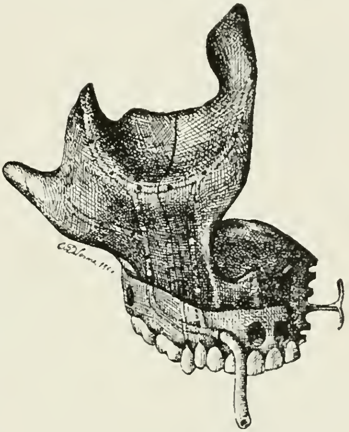
FIG. 44. — Temporary Appliance for Use in Immediate Prosthesis Following Resections of the Maxilla. Assembled appliance. (Martin.)

The size and form of the appliance are obtained from a natural maxilla that matches in size the one which is to be resected. The vulcanite jaw is made larger rather than smaller than the part to be removed, and then, at the time of the operation, it is reduced to accord with the necessities of the case. It is held in place only by the clasps which encircle the teeth or by the spring that extends to the lower jaw. Martin says that in some cases he has been able to remove the temporary appliance at the end of a month, while in others it has had to stay in eighteen months.

The Permanent Appliance. The permanent appliance (Fig. 45) is to be introduced after the wound has completely cicatrized. The first step required is to take an impression of the mouth and the cavity of the removed bone, for it is intended that the appliance shall fill this completely. To accomplish this, the impression composition is softened by heat and then packed into the deepest portion of the cavity in small pieces. When each of these portions has been given the proper shape it is thoroughly chilled and hardened and then oiled, to permit its remaining separate from succeeding portions. The packing is done with the fingers, and, when the cavity is full, an impression of the mouth is taken as in ordinary cases. The impression is removed in sections which are fitted together, and a cast is made in the usual manner.

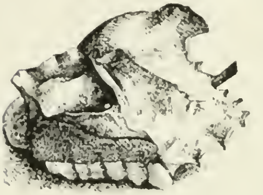
Fig. 45. Permanent Appliance for Use in Immediate Prosthesis Following Resections of Maxilla. Oral portion of appliance, showing thin projecting edge which enters the cavity of the resection. (Martin.)

The temporary appliance should not be removed until the permanent one is ready to be introduced, as otherwise in a short time sufficient contraction would ensue to make this impossible. Martin relates a case in which the appliance was left out for twenty-four hours, when its introduction was effected only with very great difficulty.

The lower portion of the appliance is made separately of hard rubber like any dental plate, the teeth being mounted upon it. Its upper surface should present a raised edge that enters the cavity in the soft tissues. The remaining portion is made of soft rubber (pure Para rubber, with six per cent of sulphur, and vulcanized for a long time at a low temperature); it is hollow in order that it may be very light in weight, and is constructed in the mould of the space which it is to occupy. It is filled with water while it is undergoing vulcanization, in order to keep it distended and to give it the necessary form. This water is removed subsequently by an opening made in the hard-rubber portion, and this opening is then stopped up with a screw to prevent the ingress of foreign matter. The portions of the appliance which are so arranged as to oppose the contraction of the scar are of hard rubber, while the other portions, which are to be in contact with the delicate lining membrane of the cavity, are of soft rubber.

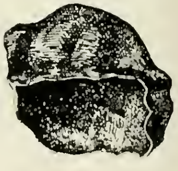
Fig. 46. — Soft-rubber Bulb Portion of Appliance for Resected Maxilla, to be Joined to Portion Shown in Fig. 45. (Martin.)

The Use of Ante-operative Appliances, and the Post-operative Treatment of Mandibular Resections.—In cases in which immediate prosthesis is not possible, Claude Martin * has proposed what he terms *la prothèse ante-opératoire.* This consists in placing in the mouth, before the operation, an appliance which prevents the drawing in of the remaining portion of the mandible by the contracting cicatrix, and yet permits the separation of the jaws. "When the surgeon has marked out his field of operation, we place on the fragment of the lower jaw which is to be removed—for this kind of prosthesis can be applied only when a portion is to remain—an appliance of vulcanized rubber that fits the remaining teeth and is fixed to them by screws, if its own adhesion is not sufficient to retain it. This appliance carries an external lateral wing which is directed upward and which is to engage a second wing attached to an analogous appliance fixed to the upper jaw. The upper wing is situated inside that attached to the lower jaw, a fact which permits the remaining fragment of the lower jaw to resist the traction exerted upon it by the muscles. This traction not only causes a deformity of the corresponding jaw, but also prevents mastication, which in these cases plays such an important part in maintaining the proper standard of health. In a word, the ante-operative prosthetic appliance serves to keep the fragment in its proper position. (Fig. 47.)

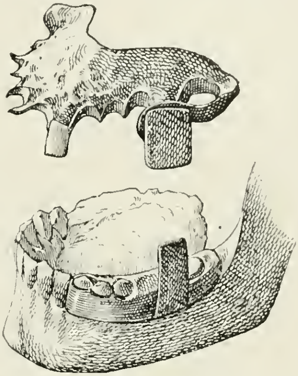

FIG. 47. Ante-operative Appliance Put in Place Before the Operation of Resection of the Mandible to Prevent Its Retraction by Cicatricial Contraction. (Martin.)

"We ought to add that the two appliances, upper and lower, are placed in position three or four days before the operation, in order that the patient may become accustomed to them, and that the surgeon, at the time of the operation, may not have to remove them if his field of operation has to be limited.

"But, it may be asked, what will become of the side of the jaw from which a part was resected? Cicatricial bands will be established, and in a short time the patient will not be able to utilize the resected side for mastication, and there will always, of course, be some disfigurement.

"It is at this time that we intervene by means of *la prothèse tardive,* employing the weighted appliances which have proved so useful in our hands.

"When the cicatrization is entirely completed, we attach with screws, to the ante-operative appliance of the lower jaw, another piece of vulcanized rubber which is of such shape as to complete the lower dental arch. When the patient can wear this with comfort, we add to its lower surface a block of tin, the full length of the resected part. Little by little this block makes a place for itself in the scar tissue, partly by reason of its weight, partly because of the massage which results from the movements of deglutition and mastication, and also partly because of the external massage which the patient himself should make upon the scar. When this has taken its place, we add, by means of screws, first one and then another new block of tin until the constantly increasing weight shall have, by slow stages, produced a depression in this cicatricial mass, and shall have restored the correct contours of the face. (Figs. 48, 49, and 50.) Then, taking this apparatus composed of blocks of tin as a model, we construct the permanent appliance of vulcanized rubber, to which are attached the artificial teeth. This appliance the patient is able to insert like an ordinary denture."

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* "Traitement prothetique dans les Résections du Maxillaire inférieur." Le Laboratoire, November 18th, 1906, p. 678.

In a case reported by A. Chiavaro,* in which nearly one-half of the body of the mandible and all of the ramus including the head were removed because they were the seat of a multilocular cyst, the following details are worth recording here:—Immediate prosthesis was not undertaken because the author was absent at the time and did not see the patient until thirteen days after the operation. Shortly thereafter an appliance with lateral wings was made according to Martin's method. It was of sufficient bulk to induce the gradual distention of the scar area. The patient wore this for a month and then, in spite of the advice of M. Chiavaro, he discarded it. He complained of the wings and said that he suffered considerably from the pressure which they exerted upon the scar; he also feared a return of the tumor. At the time when he discarded the appliance, his teeth fitted together correctly and, by holding the remaining half of his jaw in place by pressure with his tongue, he was able to open his mouth with but very little deviation of his chin. He was able to speak with his teeth closed, and he could eat solid substances, even crusts of bread. He also kept his teeth closed during sleep. He was unwilling to return to the appliance, and so it was left out permanently. Notwithstanding the shortness of the time during which he had worn the appliance, its use had enabled him to correct nearly all the disastrous results that usually follow such resections.

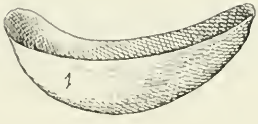

Fig. 48.

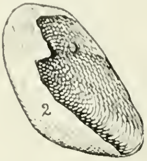

Fig. 49.

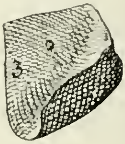

Fig. 50.

Fig. 48. Addition of Block Tin to Increase the Bulk and the Weight of an Appliance for the Purpose of Distending the Scar in a Case of Mandibular Resection. (Martin.)
Fig. 49. Later Addition of Block Tin to Distend Scar. (Martin.)
Fig. 50. Third Addition of Block Tin to Distend Scar. (Martin.)

Keyser † constructed an artificial mandible for a patient whose entire mandible had been removed on account of necrosis. He began to distend the scar by using a small jaw of hard vulcanite fitted to the soft tissues of the floor of the mouth and attached to the upper teeth by means of springs such as were formerly used on dental plates to hold them in place. These springs served to keep up constant pressure on the soft parts, with the result that in time the tissues yielded. As absorption went on and the space occupied by the artificial jaw increased, additions were made to the apparatus, first in shellac, and afterward in hard vulcanite. When sufficient space had been secured, a permanent fixture bearing ten artificial teeth was prepared to fit the space. At the site ordinarily occupied on each side by the molars, there was an elbow-like projection of platinous gold wire, the bent end of this being placed transversely to the jaw. These ends fitted into slots attached to crowns upon the upper teeth—an arrangement which permitted hinge-like movements on the part of the jaw and also its removal as a whole for purposes of cleanliness.

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* Le Laboratoire, November, 1905, p. 839.

† The Dental Cosmos, vol. xli., p. 517.

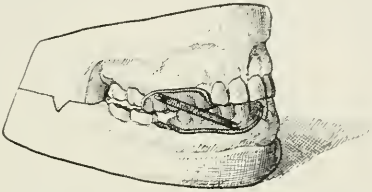

Fig. 51.—Appliance to Prevent Movement of Fragment by Cicatricial Contraction After Mandibular Resection. (Lemerle.)

Various appliances have been suggested for the reduction of the deformity due to resection of the mandible in cases in which no provision had been made beforehand to prevent it. They are all based on the general principle of applying gentle traction upon the fragments which have been approximated by the cicatricial contraction.

In cases in which teeth remain on both sides of the jaw, Martin * causes the contracted arch to spread by means of a screw acting upon a divided plate which fits the inner surfaces of the teeth. In a case of hemiresection, Delair † applies force, from a cap firmly attached to the head, through the medium of a long spring that extends around the face and enters the mouth, its end being attached to the bony fragment. Lemerle ‡ has devised an appliance which is illustrated in Fig. 51, and which is suitable only for cases in which teeth exist both in the remaining portion of the lower jaw and in the upper jaw. It consists of two silver caps, each of which covers several teeth. One is fitted to the teeth of each jaw, and each has upon its external surface a hook for the attachment of a rubber ligature. The ligature extends from one jaw to the other and its action is to draw the lower fragment into its former position.

Sébileau,§ in order to avoid the disadvantages of Martin's immediate prosthesis on the one hand, and the poor results of post-operative prosthesis on the other, has proposed still another method of prosthetic treatment, suitable for use in mandibular resections. He suggests the application, before the operation, of the appliance of Lemerle above decribed, to prevent the displacement of the jaw. The jaw is resected and the wound closed, the mucous membrane of the floor of the mouth being stitched to that of the cheek, and the external wound is closed by sutures. After the wound has healed, he performs another operation. He opens the face at the site of the missing jaw, being careful not

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* "De la Prothèse immédiate," p. 187.

† L'Odontologie, Feb. 26th, 1906, p. 157.

‡ Le Laboratoire, Jan. 26th, 1908, p. 48.

§ Le Laboratoire, Feb. 10th, 1907, p. 88.

to open a communication with the mouth, and inserts a jaw of silver which is securely attached to the remaining fragments of bone by bolts. Afterward he closes the external wound over it, the whole being done, of course, aseptically, and the wound being closed without drainage. At a still later date a plate carrying substitutes for the missing teeth may be provided by means of a very simple dental prosthetic operation.

V. SPLINTS FOR FRACTURED MANDIBLES.

In the treatment of fractures of the mandible, the dentist is frequently called upon to assist the surgeon by the construction and adjustment of dental or interdental splints. While such operations are of course not prosthetic, descriptions of them are often included in treatises on dental prosthesis, for the reason that the same materials and methods are employed in their construction as in prosthetic work. The appended account of these appliances is to be read in connection with the treatment of fractures of the mandible on pp. 103–105 of Volume III.

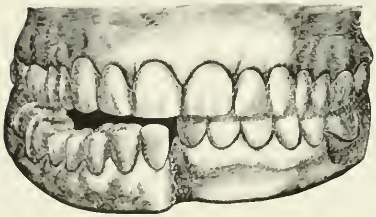

FIG. 52.—Cast of Fractured Mandible. Made from impression taken without reduction of fracture. (*The Dental Cosmos.*)

In the treatment of fractures of this bone—as it is, indeed, in the treatment of all fractures—the main object is to secure the coaptation of the fragments and their retention in proper relation during the healing process. This latter part of the treatment is usually accomplished best by means of a splint adapted to the teeth, when these are present, or adapted to the jaws inside the mouth, when the teeth are absent. In some instances the splint may be affixed only to the teeth of the mandible itself. When thus applied it serves to hold the fractured portions in proper relation and permits the movement of the mandible in its various functional activities. This is known as a dental splint. An interdental splint fits both upper and lower teeth, and usually the mandible, under these circumstances, is immobilized in a position in which the teeth occupy their places in the splint through the support furnished by a Barton's or similar bandage.

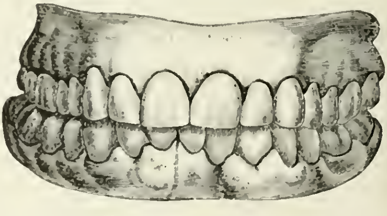

FIG. 53.—Rectified Cast of Fractured Mandible, with Teeth Occluding Correctly with Those of the Maxilla. (*The Dental Cosmos.*)

The splint should be designed and constructed with a view to its service in opposing the muscular action which, without such opposition, would cause a displacement of the fragments. The necessity for the union of the fragments in a correct relationship is especially marked in fracture of the mandible, as the least inaccuracy in the proper adjustment of these fragments is followed by a defect in the occlusion of the opposing teeth and consequently by a diminution in their functional efficiency.

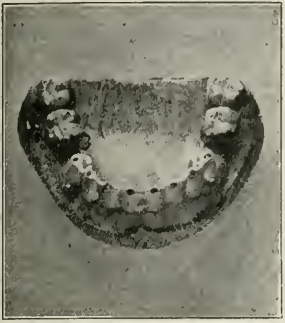

FIG. 51.—Simple Dental Splint of Swaged Metal. (Moriarty, in *The Dental Cosmos.*)

An impression of the fractured jaw is taken in plaster of Paris without any attempt at reducing the fracture. A large oiled impression tray is used, and, when the plaster has set, it is withdrawn and the plaster removed in sections. A cast is made from this and a cast of the upper jaw is also obtained in a similar manner. (Fig. 52.) Then the cast of the mandible is divided with a fine saw at the site of the fracture. These several pieces, after they have been arranged so that the teeth occlude properly with those of the upper jaw, are united with soft plaster. (Fig. 53.)

For cases of simple fracture at the symphysis, at the site of the canine tooth, or at any intervening place, a simple dental splint—provided a sufficient number of teeth are present in the lower jaw—is to be preferred to all other appliances. (Fig. 54.) This is made of aluminum (24 gauge), German silver (30 gauge), or gold (30 gauge), and is constructed by swaging a sheet of any of these metals over a zinc die obtained from the rectified plaster cast. It is in the form of a trough or gutter covering the crowns of all the teeth in the jaw or a sufficient number on each side of the fracture. This is firmly cemented to the teeth, the latter correctly fitting it when the fracture has been reduced. This splint will effectively prevent the displacement of the fragments from muscular action, and has the great advantages that the patient may almost at once use the jaw for mastication, and

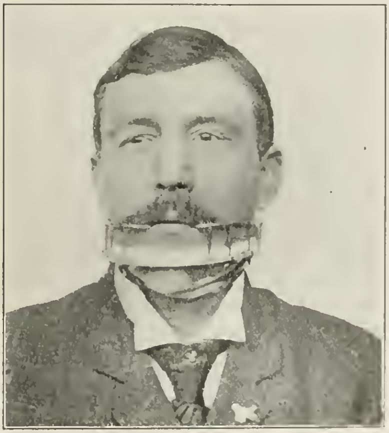

FIG. 55.—Dental Splint Supplemented with Metal Chin-piece to Permit Pressure upon the Teeth. (Moriarty, in *The Dental Cosmos.*)

that the mouth (if the fracture is compound) may be readily kept clean and in a comparatively aseptic state.

If the fracture is located farther back in the mouth and in the molar region, the Kingsley splint or one operating upon a similar principle (Fig. 55) is necessary, as the splint just described is not capable of retaining the fragments in correct apposition. The splint required fits all the lower teeth and, attached to its outer sides, are stout wires that project from the corners of the mouth over the cheeks and afford a *point d'appui* for a bandage or cap under the chin for the transmission of pressure upon the splint. By this means the continued pressure approximates the fragments and the patient is able to use the jaw for mastication. If the fracture is back of the teeth or at the angle, such a splint does no good unless it be assisted with a bandage that passes from the chin over the back of the neck, to counteract the effect upon the position of the ramus caused by the traction of the elevator muscles.

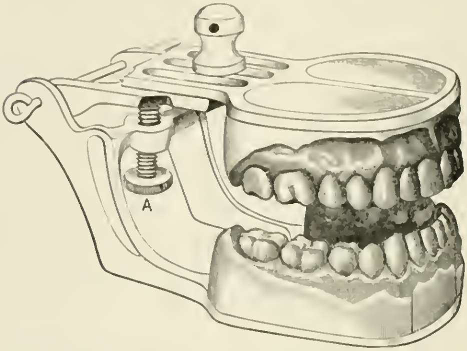

Fig. 56. Corrected Casts upon the Articulator. ("American Text-book of Prosthetic Dentistry.")

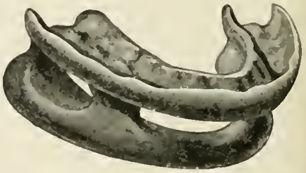

Fig. 57. Interdental Splint of Vulcanite. ("American Textbook of Prosthetic Dentistry.")

If the fracture is comminuted an interdental splint will give good service. This type of splint may be used in any variety of fracture of the jaw, but it has several objectionable features which are a drawback to its general employment. For example, it is impossible to keep the mouth clean when it is in place, and the patient must be fed a liquid food introduced through an opening in the splint between the two rows of teeth, or at a point where teeth are missing. A tube may be also passed back of the last molars, or possibly through the nose. The splint is made of vulcanite or of swaged metal (German silver or gold), which latter is to be preferred on account of its smaller bulk. The casts of the jaws are to be mounted on an articulator at the same distance from its joint mechanism as the jaws are from the temporo-mandibular joint, in order that, when they are separated for the construction of the splint, they may have the same relation which the jaws would occupy if separated to the same extent. (Fig. 56.) The splint is made to cover the crowns of the teeth and yet permit them to enter easily the compartments provided for them. An anterior opening is usually provided for the intake of food. (Fig. 57.) After the splint has been inserted, a Barton's bandage holds the lower jaw in place.

If the jaws are edentulous, it is usually necessary to employ an interdental splint constructed by wiring together the artificial dentures themselves, or, if the patient is without these, it is necessary to make an interdental splint which fits the jaws. If the fracture is at or near the symphysis, it is possible to prevent the displacement of the fragments by attaching wire arms to the lower plate, and, by applying a submental cap or bandage, thus to utilize the principle of the Kingsley splint.

The only other alternative, in edentulous cases, is wiring the fragments; but this would necessitate in some instances the conversion of a simple into a compound fracture; and at best the wires soon get loose and necrosis is apt to result at the site of their insertion.

In extensively comminuted fractures one may advantageously use Angle's fracture bands, which are applied to the teeth and afford a means of ligating them to each other and to those of the upper jaw.

SURGICAL DISEASES AND WOUNDS OF THE NASAL CAVITIES AND ACCESSORY SINUSES.

By HARRIS PEYTON MOSHER, M.D., Boston, Massachusetts.

There is scarcely another part of the human body in regard to which a knowledge of the anatomical construction and relations of the parts is of so great importance to him who would treat the diseases and injuries of this region as it is in regard to the nasal cavities and their related sinuses. And yet it is still a difficult matter for most surgeons to get access to this knowledge, which is largely stored up in the periodicals and monographs devoted to the interests of those who work in this department as specialists. The writer has, therefore, deemed it wise to devote an unusually large part of his allotted space to the descriptive and applied anatomy of the nasal region.

I. DISEASES OF THE NASAL CAVITIES.

Epistaxis.—Etiology.—In patients of middle age epistaxis may be the first expression of some general disease—*e.g.*, cirrhosis of the liver, disease of the heart, or chronic disease of the kidneys. In patients of the proper age these affections should be searched for. Epistaxis is often due to direct trauma. The bleeding in such instances, although at first profuse, stops readily and causes little anxiety. The majority of cases of nose-bleed which come to the physician are due to trauma localized upon the anterior inferior part of the septum. Bleeding from this locality has a tendency to recur, and often is difficult to check.

Bleeding that occurs in spurts is usually arterial, and generally comes from one point. This point is almost invariably on the anterior inferior part of the quadrangular cartilage, rarely more than an inch from the nasal opening. Epistaxis is common in children, because in the mucous membrane of a child's nose the vessels are relatively large and are superficial. The frequency of epistaxis in typhoid fever has been overrated. When it occurs it is probably due to the removal of scabs from the bleeding area of the septum by blowing or by picking the nose.

The Blood Supply of the Septum.—The chief artery of the septum is the spheno-palatine, a terminal branch of the internal maxillary. This enters the nose from behind, coming from the spheno-maxillary fossa. When it has gained the nose through the posterior superior angle of the nasal cavity, the artery crosses the lower portion of the front face of the sphenoidal sinus, and then turns sharply forward upon the root of the vomer. From here it runs downward and forward, at once dividing into two main branches, one of which skirts the upper border of the vomer, while the other runs below it. From the lower branch comparatively stout arterial twigs are given off at intervals. In the anterior part of the nose these little branches seem to come from the floor of the nose. One of these twigs is often the main supply of a bleeding point. When the septum is straight the arterial twig is easy to find, but, if there is a spur, not only the branch which supplies the bleeding point, but the bleeding point itself, may be under the spur. Both main branches of the spheno-palatine artery end upon the posterior half of the quadrangular cartilage. The upper part of the septum is supplied by the ethmoidal arteries. The first and most important artery approaches the septum from behind and from above; the artery next in importance approaches the septum from the front and from below. This second vessel is the septal artery. It is a branch of the artery of the upper lip, and it reaches the anterior part of the quadrangular cartilage, which it supplies, by passing from the upper lip through the vestibule into the nose. The terminal twigs of all these arteries centre upon the quadrangular cartilage, and make there a sizable arterial plexus. In connection with this, special arterial papillæ have been described. The mucous membrane which covers these vessels, and the cartilage upon which they rest, are both thin. The arterial plexus just mentioned is poorly situated, for several reasons: in the first place, it is at this point that the incoming current of air first strikes the septum; then, besides, there is at this point a constant blast of dust; and, finally, this point is just within reach of the picking finger or the twisted corner of a handkerchief. Naturally, therefore, this part of the septum is often abraded, and as a further result it is correspondingly covered with scabs. As the scabs are blown or picked off, bleeding is started. On this account the anterior inferior part of the quadrangular cartilage is called the ulcer area, or the bleeding area.

Treatment.—In most cases a nose-bleed ceases of its own accord or is stopped by the application of such household remedies as ice to the back of the neck or to the bridge of the nose, by pressure on the upper lip, by the insertion of a bit of cotton into the nasal orifice from which the blood is escaping, or by raising the arms high above the head. Cold acts through the vasomotor nerves, pressure on the upper lip compresses the septal artery, and raising the arms above the head promotes the force of aspiration and often quickly controls epistaxis. In those cases in which the services of a physician are sought, the first thing for him to do is to locate the bleeding point. In searching for this, he should always bear in mind that in the great majority of cases the bleeding point is on the anterior inferior part of the septum, and, therefore, is easily accessible for cauterization or for the application of pressure. The frequent use of the post-nasal plug for controlling epistaxis shows that the physician is ignorant of this fundamental fact. In order to find the bleeding point, it is necessary to calm the patient and the attendant family, to clean out the clots in the nose, and to insert in the nostril a cigarette of cotton saturated with a solution of adrenalin chloride of full strength. With the adrenalin it is well to mix some cocaine. While waiting for these drugs to take effect, the patient should be well covered up, and should be given a basin to hold. The physician then makes a number of cotton cigarettes, in order that he may have them ready at hand for rapid working. If the patient is seen at his home, a bead of chromic acid is fused upon a wire nasal applicator, as bright a light as possible is obtained, and some one is delegated to steady the patient's head. When everything is ready, the bleeding point is located by quick swabbing, and, if it is possible to get it dry, it is touched with the bead of chromic acid. Not only is the bleeding point cauterized, but so also are the roots of any vessels which are seen running to it. In the physician's office the galvano-cautery can be used in place of the acid. If the bleeding is checked by this procedure, and in the majority of cases it can be so checked, a sizable cigarette is made of cotton, wrapped with Cargile membrane, and inserted straight back in the nose, well beyond the bleeding point. A second plug may be placed above the first one if it is thought necessary. The patient is told to spend the night in the sitting posture, and not to take any warm drinks or warm food. After twenty-four or forty-eight hours the nasal plugs are removed. The Cargile membrane allows the plugs to slip out with little, if any, renewal of the bleeding. When the plugs are out, the nose is again cocainized and adrenalized, and the nasal mucous membrane cauterized about the edges of the original bleeding spot. An attempt is made to find and to obliterate any vessels which are seen to be feeders for this. Unless the original scab is very large it is not removed. It is well to see the patient a week later, and again to investigate for vessels running to the bleeding point. If such are found, the attempt should be made to obliterate them by using trichloracetic acid. This has a milder cauterizing action than chromic acid, and so can be used with greater freedom. The patient is told to correct his habit of picking the nose, and he is given an oil spray to use until the scabs have ceased to form and the ulcer produced by the cauterizing has completely healed.

If, when the bleeding point is found, the flow of blood is so severe that it at once washes away the caustic and prevents its action, it is better to shrink the vessels with a temporary plug of adrenalin, and then to depend upon the pressure of a permanent plug for the control of the bleeding. Plugging the nose is best accomplished by using a long-bladed nasal speculum of the Killian pattern, and a stout pair of bayonet forceps. The ordinary angular nasal forceps which are used for examinations are much too weak. Four or five cigarettes of cotton or gauze, each the size of the little finger, are gotten ready, and two of these are wrapped with Cargile membrane. The patient's head is held steady, and the nose is cleared of clots by rapid swabbing. Then the long-bladed speculum is introduced in the inferior meatus and carried back along the floor of the nasal passage. A cigarette wrapped with membrane is passed into the nose the whole length of the plug and crowded firmly downward. The speculum is taken out and placed above this plug, and a second protected plug is introduced and crowded down upon the first one. A third or a fourth plug may be placed in the nose, according to the size of the nasal cavity and the severity of the hemorrhage. The upper plugs may be taken out on the next day in order to lessen the headache which they often cause. The remaining plugs are left in until the third or perhaps the fourth day. When the plugs are finally removed, the bleeding point should be located and cauterized.

In the most severe forms of bleeding it is better to use naked gauze in order that the blood may clot in its meshes. In such cases small strips of gauze about two inches long are packed in the nose after the fashion of the cigarettes. These are placed one upon the other, and firmly crowded down into place. They are carried well back so that the lower ones protrude through the choana into the pharynx, and so plug the posterior nares from the front. If the work is done slowly and carefully, practically all cases of epistaxis can be controlled in this way, and the necessity of posterior plugging avoided. The number of pieces of gauze placed in the nose should be counted, so that all may be recovered. It may require as many as ten or twelve of these small pieces of gauze thoroughly to tampon the nasal cavity. In order still further to guard against losing a strip of gauze, each piece can have a thread tied about it, and the ends of these threads may be allowed to come out of the nose. In unpacking the nose, each thread should come out with a plug. The upper plugs, which are the hardest to see, may be removed by traction on the thread, provided a stout thread is used.

There remain a few cases of epistaxis which are controlled with difficulty even by this form of exact and thorough packing. Such cases occur, as a rule, in bleeders or in patients subject to disease of the liver, the kidneys, or the heart. In such cases the gauze used for the packing may be saturated with tannin (never with perchloride of iron, because this makes a large, dirty clot which readily becomes septic) or with melted gelatin, or even, in the most severe cases, with collodion. The use of collodion is painful. This, of course, is a small matter where life is at stake. In these desperate cases not only is the nose packed, but the patient is given enemata of gelatin and fed gelatin by mouth. Adrenalin chloride, of full strength, can be given, at first subcutaneously, and then in ten-minim doses every four hours by mouth. The patient should be kept absolutely quiet, and, if not too weak, he should remain in the sitting posture. The thirst is allayed by enemata of salt solution. Nothing warm is given by mouth. Advantage should be taken of the salt enemata to give nourishment by rectum. In any operation about the nose or the throat where there is reason to fear excessive bleeding, lactate of calcium should be given for a few days before the operation, in order to increase the coagulability of the blood. This drug should also be given a trial in all cases of stubborn epistaxis.

When a practitioner feels that he is not familiar enough with intranasal manipulations to use the form of packing just described, he should employ the post-nasal plug. This is made in the following manner: A piece of gauze is folded into a plug as large around as the thumb and an inch and a half long. The plug should be rather bulky because each choana is one inch high and half an inch wide. When the plug is ready, a gag is placed in the patient's mouth, and a small but rather stiff rubber catheter is oiled and passed straight back through the nose into the pharynx until it drops below the soft palate. From here it may be hooked forward and out of the mouth by the finger placed in the pharynx. A better way is to hold the tongue down with a tongue depressor, to illuminate the pharynx with light from a head mirror, to see the end of the catheter, to grasp it with a long pair of angular forceps, and thus to bring it out of the mouth. To the end of the catheter a large, stout string is now tied, and the catheter is drawn back through the mouth and out of the nose, carrying the string with it. The nasal plug is tied to the lower end of the string, the string being placed about the middle of the plug. The plug is fastened at least six inches from the end of the lower half of the string in order that some of the string may project from the mouth after the plug is in place. By pulling on this it is not difficult to remove the plug. When the plug is firmly tied to the string, the end of the string which comes out of the nose is pulled upon, and the nasal plug is carried into the mouth and guided by the forefinger past the soft palate up into the post-nasal space. When the plug has passed the soft palate it is pulled strongly forward: at the same time the finger in the vault pushes it firmly into the choana. An assistant keeps up traction on the nasal end of the string while the physician packs the nasal cavity full with strips of gauze, packing the gauze well back against the post-nasal plug. When the nasal cavity is filled, a small plug of gauze is placed across the opening of the vestibule and tied firmly to the string which comes out of the nose. It would seem as if this kind of packing should effectively control any form of epistaxis, but the fact remains that a few cases resist all kinds of packing and all forms of treatment, and slowly progress to a fatal ending. In treating epistaxis, a physician is often sorely tried to keep the proper perspective of the case, and not to share the alarm of the patient and his friends. Nothing produces this effect upon the physician more quickly than prolonged watching over these difficult cases. He should, therefore, lighten his responsibility by having a second physician take his place from time to time. To do the right thing at the right time, neither to delay nor to hurry the use of extreme measures, should be the aim in treating hemorrhage.

The post-nasal plug should never be left in place longer than forty-eight hours.

If possible, it should be removed at the end of twenty-four hours, as the plug can readily start up trouble in the middle ear by causing infection. Before the nasal packing is removed, the gauze should be moistened with oil dropped into the nose. The post-nasal plug should be moistened in the same way. When the plug is first removed, never cut the string, but detach the plug from it, and replace a new one on it. Tie the two ends of the string together and let the patient wear the loop carrying the new plug over the ear. In case the plug is needed again, it is ready. In some cases the end of the string which comes out of the mouth saws into the soft palate. In order to avoid this, some physicians cut off the end of the string that comes out of the mouth, and remove the plug with bent forceps passed through the mouth into the pharynx. It is safer to leave the end of the string projecting from the mouth.

Abscess of the Septum.—Following a blow or a fall on the nose the cartilage of the septum becomes folded upon itself, and then, with the release of the pressure, resumes its original position. The force of this bending and subsequent straightening of the cartilage may elevate the overlying mucous membrane. If the trauma is severe enough the cartilage is actually broken. Accompanying the loosening and the elevation of the mucous membrane there is an exudation of serum or blood, with the formation, at times, of a hæmatoma. This very often becomes infected. Infection having taken place, the pus further dissects up the mucous membrane on both sides of the cartilage and then attacks the cartilage itself. In this lies the danger of abscess of the septum. The lower half of the bridge of the nose is supported by the anterior edge of the quadrangular cartilage. If this part of the cartilage is destroyed, the lower part of the bridge of the nose will fall. In the majority of cases, marked falling of the lower part of the bridge of the nose follows an extensive abscess of the septum.

The innumerable small injuries of the nose in childhood result only in a temporary nose-bleed. In childhood the surface of the mucous membrane usually breaks without any elevation of the mucous membrane from the cartilage underneath. One should bear in mind, however, that such an abrasion may become infected, and that the infection may then be carried to the cartilage, the pus burrowing until a sizable abscess is formed. Occasionally, however, the trauma is applied in such a manner as to loosen the mucous membrane from the cartilage, and thus to give rise—to borrow a term from obstetrics—to an internal concealed hemorrhage. Abscess of the septum is fairly common in childhood, and therefore its occurrence should be borne in mind as a possibility after any form of trauma inflicted upon the nose. Where a child has injured his nose and free nasal breathing does not return in a few days, and especially if the child complains of increasing pain, the condition of the septum should be determined by examination with the speculum. In the adult, abscess of the septum is commoner than in the child, not because trauma is more common, but because the septum is less yielding in the adult, and because the trauma, when it does occur, is more severe. Men who box and those who resort to the use of their fists for the settling of differences are especially liable to abscess of the septum. They are liable also to hæmatoma and abscess of the auricle of the ear. The two processes are essentially the same, except that one occurs on the surface of the body and the other within the body. In hæmatoma of the ear, the liquefaction of the cartilage is followed by shrinkage of the soft parts over the cartilage and serious deformity. The form of the external ear is dependent upon cartilage alone, while the form of the nose, fortunately, is dependent upon both cartilage and bone. The deformity of the ear resulting from hæmatoma and abscess of the auricle, therefore, is more serious than the deformity which results from hæmatoma and abscess of the septum, but the deformity of the nose may be very distressing. After abscess of the septum it is not rare for the whole cartilaginous bridge to sink, producing a very ugly saddle-back nose. The ear is on the side of the head, and is consequently a less conspicuous object; but the nose is in the centre of the face, and therefore any deformity of the part attracts much more attention.

After blows on the nose, with or without fracture of the nasal bone, the septum should be watched carefully. By examining with a probe it is easy to determine, not only whether the mucous membrane is elevated from the cartilage at any point, but also whether or not there is fluid under it. Wherever the mucous membrane is found to be loose and bulging, a free incision should be made down to the cartilage, and the blood evacuated. The incision should be kept open and drained until the exudation stops and the mucous membrane has reattached itself. In this way many a hæmatoma may be prevented from becoming infected, or, if it should become infected, the resulting abscess will be small, and the cartilage will undergo only a slight degree of necrosis. Unfortunately, many patients do not come for treatment until the hæmatoma has become infected, and sometimes not until an abscess is present. In such a case the patient generally gives a history somewhat like the following: He received a blow upon the nose, and this was followed by nose-bleed. After the bleeding had been controlled, he examined his nose, but was unable to make out any loosening of the bones; and when he looked in the mirror he could discover no appreciable degree of deformity. Satisfied that a fracture had not taken place, he thought no more of the incident at that time. In the course of a day or two, however, he noticed that the nose began to be blocked, and that the degree of obstruction was increasing. In addition, the nose became painful, and the pain increased. Then, at last, he decided to consult a physician in order to ascertain whether or not his nose "is broken inside."

Diagnosis.—The external examination of the nose, in such a case, shows nothing. When the patient's head is tilted back and the tip of the nose is raised so that the nasal openings can be inspected, it is noticed that a red swelling blocks each nostril. When, with the aid of the nasal speculum, these bilateral swellings are examined, they are found to be painful and fluctuating—in other words, there is an abscess of the septum.

TREATMENT.—Both swellings should be freely opened, the pus evacuated, and a wick introduced into each. In some cases it is well to punch out a small piece of the mucous membrane so that the incision shall not close. For the first twenty-four hours the wicks should be allowed to remain undisturbed. Then the wick should be removed from one side, and the upper part of the corresponding nasal cavity, below the cartilaginous bridge, should be packed with gauze and a tubular splint put in below this to keep it in place. Fresh wicks should be inserted into the opening made in the other side until pus shall have ceased to discharge. If the attempt to support the bridge by the packing of one side of the nose interferes with drainage, the packing should be discarded temporarily. Later, when the suppuration has been brought under control, this procedure may be resumed. If there has been much destruction of the cartilage, the bridge should be supported for two or three weeks. The important thing about abscess of the septum is that it should be watched for and treated at an early stage and thoroughly, in order to minimize the subsequent deformity. In the very beginning the patient should be told that there will probably be some deformity after the abscess has run its course. Impress upon him that regular treatment is necessary in order to reduce the deformity to a minimum. Unless this is done, the physician is almost always held responsible.

Fracture of the Nasal Bones.—Fracture of the nasal bones, or broken nose, is due to external violence in the form of falls and blows. All degrees of fracture occur, from the case with a slight crack of one or both nasal bones, with no displacement, to the case where the nose is laid flat with the face. The direction from which the blow comes determines, in a great measure, the character and the seriousness of the deformity. The nasal bones are so buttressed by the ascending processes of the superior maxillæ that they will stand a much severer blow from the front without fracture than from the side. In most cases the blow comes from the side. In such a case the deformity is of two kinds: lateral deviation of the nasal bones, and depression.

After trauma the soft tissues of the nose swell very rapidly, and consequently a slight deformity is at once disguised. It should be made a rule, therefore, in all doubtful cases, and in all cases of women and children, to give gas or ether before making a diagnosis of fracture or before excluding fracture. It is imperative to examine under an anæsthetic where there is much swelling. If this is not done, the practitioner will have certain cases in which, on the subsidence of the swelling, the persisting deformity will show that there has been a fracture. Parents always think, when the question of fracture is raised, that their children have had straight noses, whereas they, in reality, have had a slight deviation. In making a diagnosis, therefore, the surgeon must always bear in mind the possibility of such an error in statement. No fracture in the body shows plainly than fracture of the nose. If the patient, or the parents of the patient, refuse consent for the administration of the anaesthetic, then the physician is freed from responsibility if subsequently it should be found that a fracture had actually occurred.

The signs of fracture of the nasal bones are deformity and crepitus. In many cases there is emphysema of the subcutaneous tissues. This is of as little significance as the black eye which usually goes with a broken nose.

In cases of slight fracture there may be no deformity, the only sign being crepitus on manipulation. Fractures of the nose, simple or compound, seldom become septic. (See also Vol. III., p. 99.)

Simple Fracture of the Nose.—In simple fracture of the nasal bones, one or both bones may be broken. If but one bone is broken, there may be no deformity. In such a case crepitus can often be obtained without ether, but under ether crepitus can be obtained always. In all but the lightest cases there is some depression, and combined with the depression there is also some lateral displacement. In the severe cases of simple fracture (simple as distinguished from compound) there is an associated fracture of the septum. The septal fracture is confined, as a rule, to the quadrangular cartilage—that is, to the anterior part of the septum. If the blow comes from above, the quadrangular cartilage tends to fold upon itself as the fingers close upon the palm. If the blow comes from the front, the cartilage again folds upon itself, but the axis of the fracture is, roughly speaking, vertical. Many severe fractures of the nasal bones show but little deformity of the septum.

Compound Fracture of the Nasal Bones.—Compound fractures of the nasal bones have a marked tendency to heal without becoming infected. Even if a nasal bone is almost completely exposed, and lies on the skin, attached only by a small piece of periosteum, it will, in the majority of cases, live, provided it be cleaned and restored to its natural position.

A proper appreciation of the anatomy of the deformity which occurs in fracture of the nasal bones is necessary for its successful correction. Many fractures are caused by a blow from the fist. Most men are right-handed, so that they "land," in the language of the ring, upon the left side of their opponent's nose. A blow squarely on the nose from the front is rare. Given a sufficient blow from the side, the left nasal bone is driven to the patient's right, and its outer edge is depressed beneath the inner edge of the ascending process of the superior maxilla, from which the blow causes it to separate. The patient's right nasal bone is also broken from its attachment to the ascending process of the superior maxilla, but, instead of being forced below this process, as happened to the first nasal bone, it is forced over it. In this way both nasal bones are locked with the corresponding process of the superior maxilla; one is locked below it, the other over it. (Fig. 58.) Before the nasal bones can be returned to their original position, this interlocking must be overcome. The nasal bones, where they meet at their inner edges in the middle line to make the bridge, may or may not be broken loose from their attachment to each other.

When the blow comes squarely from the front, the outer edges of both nasal bones are broken from their attachment to the inner edge of the ascending processes of the superior maxilla, and depressed beneath them.

Treatment of Fracture of the Nasal Bones.—The aim of the manipulations practised for setting the fracture is to raise the sunken nasal bones, and at the same time to unlock them, so that they can be moulded or sprung back into place. In order to accomplish this, a flat elevator, which will fit well up under the nasal bones, is placed in the nose under the more depressed nasal bone, and the thumb of the left hand is placed against the nasal bone which overrides the ascending process of the superior maxilla. In other words, the thumb is placed on the nasal bone which is farthest from the middle line, and at the apex of the lateral deformity. Strong upward and forward pressure is then made on the bony bridge of the nose with the tip of the elevator. As the tip of the elevator swings forward, the depressed nasal bone is elevated, and the opposite nasal bone, which is overriding the ascending process of the superior maxilla, is freed. At the moment of greatest elevation, the thumb of the left hand makes strong pressure toward the median line. (Fig. 59.) If the elevation is sufficient to correct the overriding, the nasal bones slip back with a snap to the middle line. Unless the elevation of the nasal bones is sufficient to accomplish this, pressure against the apex of the deformity serves only to defeat the correction. It is a

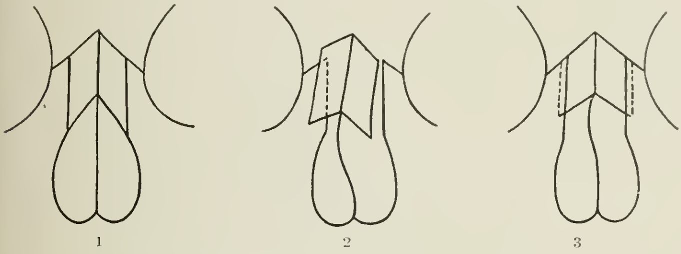

FIG. 58.—Normal and Pathological Relations between the Nasal Bones and the Ascending Processes of the Superior Maxillæ. (Original.)

(1) Normal relations. *a*, Ascending process of the right superior maxilla; *b*, left nasal bone.

(2) The usual deformity in fracture of the nasal bones with lateral displacement to the right. The outer edge of the left nasal bone is forced below the edge of the ascending process of the superior maxilla, and the outer edge of the right nasal bone is forced over the edge of the ascending process of the superior maxilla. *a*, Ascending process of the right superior maxilla; *b*, overriding nasal bone. c, depressed nasal bone; *d*, ascending process of the left superior maxilla.

(3) Fracture of the nasal bones without lateral displacement, but with backward displacement or with depression. The outer edges of the nasal bones are depressed and caught beneath the inner edges of the ascending processes of the superior maxillæ. *a*, Depressed nasal bones; *b*, ascending process of the left superior maxilla.

very common mistake to attempt to correct the lateral deformity by pressure without elevation. This results only in embarrassment. When the telltale click and the reduction of the deformity show that the nasal bones are again in the middle line, the elevator is placed first in one nostril and then in the other, and rather gentle efforts are made with it in order to mould the nasal bones into proper line. If the nasal bones are broken into a number of fragments, much can be accomplished in this manner. In many cases, however, the bones are not comminuted, so that, when the click is heard, and the bones have been forced into the median line, little or no moulding is needed. In such cases no splint is required, and no packing is necessary in the nose. In the cases where the bones are extensively comminuted, it is necessary to pack carefully the upper part of the nasal cavity under the nasal bones. This is best done with naked gauze. Care is necessary not to put in so much gauze that the nasal bones are spread. The packing is left in for two or three days. After this time it may usually be dispensed with altogether. In some cases the nasal bones, after correction, tend to spring back and to reproduce the original deformity. In these cases it is necessary to correct this tendency by a splint. If much pressure is required in order to retain the nasal bones in their corrected position, the result of the treatment usually proves to be unsatisfactory. The simpler the splint the better, provided it will keep up pressure and will not slip. All splints should be readjusted daily. Too much pressure, or pressure continued for too long a time, at one point, causes the skin to slough. Children tolerate only the simplest form of splint, so that, in the case of a child, the correction should be especially thorough. All that can be accomplished by the use of a splint is secured in the first week.

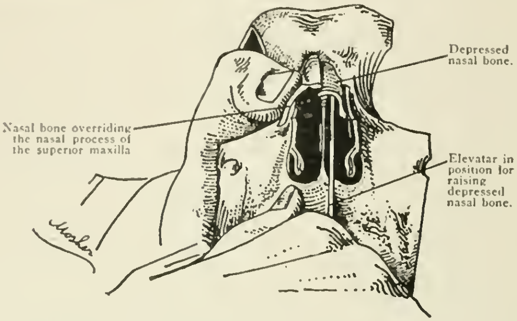
Depressed nasal bone.
Nasal bone overriding the nasal process of the superior maxilla
Elevatar in position for raising depressed nasal bone.

Fig. 59. The Usual Deformity in Severe Fracture of the Nasal Bones, and the Manipulation Required for Reducing It or for Setting the Fracture. The thumb of the left hand is in position to press the right nasal bone toward the middle line when it is unlocked from the superior maxilla. (Original.)

Where one or both nasal bones are depressed and there is no lateral deformity, the correction consists in careful elevation and moulding, and in equally careful packing of the nose.

In the most severe forms of fracture of the nose, where the nose is practically flat with the face, the same form of treatment is carried out as that which has just been described—namely, elevation and moulding and intranasal packing. In these cases the septum is extensively fractured as well as the nasal bones, so that the nasal packing must be continued for a longer time. When the nasal cavity is filled entirely with gauze, the packing soon becomes very foul. If a tubular splint is put in the lower part of the nose, with the packing above it, the packing does not need to be changed so often. The tubular splint permits a certain amount of nasal respiration, and adds very greatly to the comfort of the patient. Where but one nostril is packed it is not necessary to use the splint. All packing should be changed at least as often as every third day.

Every case of fracture of the nasal bones should be watched for the development of abscess of the septum. A hæmatoma of the septum should be opened early. An abscess should be opened freely the moment it is discovered, and watched to see that it has sufficient drainage. The deformity which results from an abscess of the septum often is worse than that caused by the fracture of the nasal bones, even if it be left uncorrected.

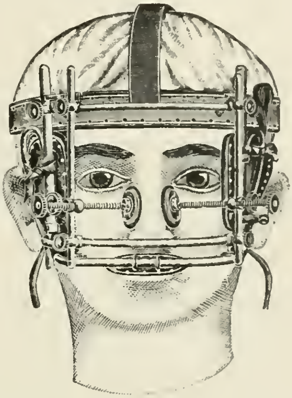

Fig. 60. Author's Mask Splint Applied.

My preference in regard to splints is for a simple moulded cap of tin, or for the mask splint. If there is much for the splint to do, I prefer the mask. (Fig. 60.)

Old Fracture of the Nasal Bones.—Fractures of the nasal bones can be set under ether as late as one week after the accident. In children it is justifiable to attempt the reduction of the deformity even in the second week. After the second week union ordinarily is so firm that reduction by elevation alone is, in most cases, impossible. When patients neglect to have a fracture of the nose treated at the time of the injury, they usually make the best of the resulting deformity for the rest of their lives. In the most marked cases of deformity, however, the patient, either for his own sake or for the sake of his friends, often wishes to have the nose straightened. On the whole, the patients who, after fracture of the nasal bones, come to the clinics in order to regain nasal respiration are more numerous than those who come to have the deformity removed; yet most of these are glad to have the deformity corrected as well as to have their breathing restored, when they learn that the deformity can be relieved.

Deformities caused by untreated fractures of the nose are divided into two groups:

1. Cases in which the nasal bones are deviated, and where the cartilaginous bridge follows the same line as that of the nasal bones. In these cases the whole nose is deviated to one side.

2. Cases in which the lower part of the bony bridge and the upper part of the cartilaginous bridge are both deviated to the same side and make a sharp angle with each other. The line of the bridge, instead of being straight, makes a V at the junction of the bone with the cartilaginous bridge, the apex of the V pointing toward the malar bone. In connection with the deformity of the bridge, the anterior portion of the quadrangular cartilage is folded upon itself, the axis of the fold being roughly vertical. This folding of the cartilage produces a sharp rectangular knuckle. The apex of this knuckle, or V, in the cartilage, points to the same side as the V made by the external deformity. Occasionally, however, the cartilaginous V is found to point into the opposite nostril. In addition to the internal deformity of the quadrangular cartilage, the upper lateral cartilage of the corresponding nostril is often dislocated. The effect of this is to broaden the apex of the external lateral deformity. If the knuckle in the anterior part of the quadrangular cartilage is large enough, it causes the lower lateral cartilage of the nose to bulge outward. When the upper lateral cartilage is dislocated, and the lower one displaced, the deformity caused by these two cartilages accentuates the deformity caused by the nasal bones, so that the nose from top to bottom appears bent to one side.

Treatment of Simple Lateral Deviation of the Nasal Bones.—At the lower outer border of each nasal bone a skin incision is made an eighth of an inch in length. In each incision, in turn, a chisel of the same width is placed, and the nasal bone is chiselled free from the ascending process of the superior maxilla. The skin of the side of the nose is readily pushed upward so that the whole length of the nasal bone can be freed without enlarging the skin incision. (Fig. 61.) When the root of the nose is reached, the chisel is turned at right angles to the first bone incision and driven through the top of the nasal bone. This procedure is carried out on both sides. The root of the nasal bone should be completely divided. When this has been done, the nasal bones can be moved readily to the median line. The nose is held in the corrected position by a pad of gauze and adhesive plaster until the patient is well out of the influence of the ether. Then a retaining splint is put on, and it should be worn day and night. If this is not possible, the splint is worn during the day and replaced at night by a simple retaining splint made either of tin or of dentist's modelling composition, and held in place by adhesive plaster. Some form of splint should be worn for about two weeks. By this time the splint will give all the correction that it is capable of giving.

Treatment of Combined Lateral Deviation of the Nasal Bones and of the Cartilag-

inous Bridge.—In combined lateral deviation of the nasal bones and of the cartilaginous bridge, the anterior part of the quadrangular cartilage generally has a perpendicular rectangular deviation which more or less blocks the nostril toward which the nasal bones deviate. This knuckle is first dissected out submucously. The removal of the cartilage is stopped a quarter of an inch from the top of the cartilaginous bridge. If the upper lateral cartilage is displaced, this is exposed from within the nose and removed. If possible, the posterior portion of the septum is not touched, but is left for a support. When the internal part of the operation is finished, the nasal bones are chiselled free in the manner just described, and replaced in the median line. When they are in the median line again, it is usually found that the stump of the ascending process of the side toward which the nasal bones deviated still makes a marked prominence. This process has been thickened by the overlapping of the nasal bone. This prominence is corrected by placing the chisel in the skin incision and slipping it outward until it rests on the ascending process of the superior maxilla. With a few taps of the mallet this process is chiselled off. Slight pressure with the finger pushes the loosened process inward, and corrects the deformity caused by it. At this point in the operation the line of the nose often is straight. In other cases, however, at the junction of the nasal bones and the cartilaginous bridge, at the apex of the original deformity, a certain amount of deformity persists. To do away with this remaining bit of deformity, the removal of which makes the difference between a fair result and an excellent one, is very difficult. It is best done by making a small incision over the apex of the deformity, and then, with a small chisel, separating the cartilage from the under surface of the tip of the nasal bone. If freeing the upper part of the septum from the under side of the tip of the nasal bone does not allow the apex of the original lateral deformity to straighten out, it is well to make a half-inch incision downward and backward into the body of the perpendicular plate of the ethmoid. This will usually allow the very apex of the V to straighten out. The deviated nostril is now packed strongly with cigarettes of gauze wrapped with Cargile membrane. The opposite nostril is lightly packed in the same manner. The nose is held in the corrected position for twenty-four hours with gauze pads and adhesive plaster, and then the mask splint is applied. The nasal packing on the off side is taken out at the end of the first twenty-four hours, and not replaced. The packing in the previously obstructed side is left in for three days, and then taken out and not replaced.

The skin incisions are so small that they do not require to be sutured. They heal readily, and leave a scar which in six months cannot be found. The incisions seldom become infected. Through fear of producing a scar, surgeons have too often hesitated to make incisions through the skin of the nose. We are now learning that the skin of the nose heals very kindly and with practically no scar. This being the case, it is much simpler and more direct to deal with most deformities of the nose through small incisions in the skin than to resort to the less direct and longer operations through the nasal canal.

After ten days the mask can be left off, and the tin cap is worn both day and night. After two weeks the cap is used only at night. It should be worn at night for at least a month. All blowing and wiping of the nose is forbidden for the same length of time. When it is necessary to clean the nose the physician must do it by spraying and swabbing.

The Subperiosteal Method of Correcting Old Fractures of the Nasal Bones.—Some operators prefer to correct deformities of the nasal bones by working from within the nose. This method will give good results. It requires more time and is less direct than the external method. For correcting simple lateral deviations of the nasal bones, the procedure is carried out as follows: The patient is etherized; the turbinates are shrunk with adrenalin chloride; an incision is made through the mucous membrane of the nose for the full length of the lower border of the nasal bone; and then the mucous membrane and the periosteum are elevated from the whole of the under surface of the nasal bone. When this is accomplished, the periosteum and the skin are elevated from the upper surface of the nasal bone. The elevation of the skin is carried, not only to the centre of the bridge of the nose, but a little beyond it, so that the skin over the bridge is thoroughly freed. The second nasal bone is denuded in the same manner as the first one. Then a flat septum forceps, of the Adams type, is placed in the nose and guided through the mucous-membrane incision until the blades grasp the nasal bone between them. The tips of the blades should be placed as near the upper end of the nasal bone as possible. When the forceps is in place, a twisting motion of the blades breaks the nasal bone from its attachment to the ascending process of the superior maxilla on the outside, and breaks it from the internal angular process of the frontal bone above. The same procedure is carried out on the second nasal bone. The nasal bones once free, they are moulded into the middle line. After the nasal bones are in the middle line, if the stump of the ascending process of the superior maxilla on the side of the original deformity is still prominent enough to make a projection, the blades of the forceps are slipped outward over it, and it is broken off in the same manner as the nasal bone was broken. The after-treatment consists in the application of a splint as soon as the swelling subsides enough to allow it to be applied intelligently. The swelling, however, is so marked that accurate adjustment of the splint is hard to obtain during the first few days. Dr. D. C. Green has developed this form of operation, and has obtained good results with it. The operation can be readily modified, should one so wish, by cutting the outer border of the nasal bone free with a chisel instead of breaking it with the forceps. The disadvantages of the operation are that it accomplishes its object indirectly, that it consumes much time, and that the swelling which results interferes with the early application of an effective splint. Fracturing the nasal bones is always less exact than cutting them free with a chisel. When, in addition to the deformity of the nasal bones, the nose is blocked from a deviation of the cartilage, the nasal obstruction is removed by the usual submucous resection of the deformity.

Deformities of the Nose.—Many deformed noses are deformed from birth. These deformities fall into one or the other of these four classes: The hooked or Roman nose; the depressed or saddle-back nose; the abnormally wide nose; and the nose with the drooping tip. Where the deformity is marked, it is perfectly natural for the patient to wish to have it removed. Where the deformity is very pronounced, the physician can easily improve the nose to such a degree that the patient and his friends will be satisfied. If, on the other hand, the deformity is slight, and yet the patient wishes to have it remedied, the physician should be cautious in promising too much. Such patients are very sensitive and are seldom satisfied with any result short of the perfection of an Apollo.

REMEDIAL MEASURES.—*a. The Hooked Nose.*—There are at least two good ways of dealing with a hooked nose uncomplicated by any lateral deformity. The simplest method, and the one which I prefer, is to make a small incision in the skin of the nose over the summit of the deformity, to free the skin and the periosteum from the part which makes the hump, and then, when necessary, to separate the mucous membrane from the under side. This accomplished, a sufficient amount of bone and cartilage is taken out to correct the deformity. If the nasal cavity should be opened up in this procedure, no special harm need be anticipated. An incision a quarter of an inch in length is usually sufficient to allow the removal of the deformity. It is better, however, to prolong the incision slightly than to bruise its edges and so prevent union by first intention. Only the finest sutures of horsehair are used. In many cases the edges of the incision lie so close together that no sutures are required. In old lateral fractures of the nasal bones, there is often a certain amount of hump. Where this is marked it is better to dissect it away. In slight cases the hump may be remedied by forcibly depressing the tip of the nasal bones. In order that the bones may sink, the cartilage of the septum has to bend upon itself. If a large hump is to be reduced by depressing the nasal bones, it is necessary to make an incision through the cartilage high up within the nose, under the nasal bones. A better plan is to take out a small piece of the cartilage under the projection so that the nasal bones can be forced down without buckling of the cartilage. If the cartilage is much bent it will slowly spring back into place.

The Intranasal Method of Correcting a Hooked Nose.—In the intranasal method of correcting a hooked nose, the nasal bones are freed from the periosteum above and below the deformity. Then a median strip of bone is removed from the central line of the bony bridge. This furrow is made of such a width that, when the nasal bones are separated by means of forceps from the ascending processes of the superior maxilla and turned toward the median line until they meet and re-form the bridge, the deformity will be done away with. It requires nice judgment to remove exactly enough bone from the median line to obliterate the deformity and not to substitute a depression for the hump. A more exact and quicker method of accomplishing the same result is to make a small external incision over the tip of the nasal bones and then with a tubular trephine to remove from the bridge a central strip of the proper width; after which the nasal bones should be freed from their attachments at their outer edges and turned inward.

b. The Saddle-back Nose.—The correction of the saddle-back deformity is best accomplished by the injection of paraffin. This material is a very useful agent, but it must be handled with great care. When paraffin was first used certain disastrous results occurred from its getting into the circulation. Hemiplegia and even death have been caused by the lodging of emboli of paraffin in the brain, and a few cases have been reported of embolus of the central artery of the retina, with loss of vision. A commoner happening has been the slipping and displacement of the paraffin. For instance, paraffin injected into the bridge of the nose has slipped down into the eyelid. By the use of a syringe which injects solid and cold paraffin all of these calamities can be avoided.

Histological examination has shown that, in most cases, the paraffin is slowly absorbed and its place taken by connective tissue. In some cases, however, it is not absorbed, but remains as a firm, harmless tumor beneath the skin. In still other cases the paraffin seems to stimulate the growth of connective tissue. What is to be its fate in the individual case cannot be told until it is injected. On this account I now make it a rule to correct the deformity in several stages, at intervals of from four to six weeks, in order to see what effect the paraffin will produce. It is difficult not to yield to the temptation to correct the whole deformity at a single sitting. In one case of pronounced saddle-back nose, in which, in the early days of the use of paraffin, I adopted this course, I soon had a marked Roman nose to deal with. Within a year I twice dissected out the superfluous connective tissue, finally getting a straight bridge.

It is important that the paraffin be injected beneath the skin, and not into it. If it is injected into the skin the skin is permanently reddened. Sometimes, even when the paraffin is injected well under the skin, the latter is made red and retains this color permanently. In slight depressions I am slow to use paraffin, but in those cases in which this deformity is well marked I consider it the best means that we have for its correction.

Method of Injecting Paraffin.—A syringe which will inject cold paraffin is to be preferred. There are no dangers connected with the employment of cold paraffin, but in this condition it is sometimes hard to mould. Every precaution for obtaining cleanliness should be taken. The assistant places his fingers at what are to be the lateral limits of the injected mass, and the paraffin is injected by the operator beneath the skin of the patient's nose in the centre of the space thus walled off. After the paraffin is injected, the physician should proceed to mould it into the proper form. The puncture is covered with a sterile cotton cocoon. The intervals between the injections should be at least four weeks.

A properly shaped piece of celluloid, placed in the gap and covered with the skin, is effective in some cases.

c. The Abnormally Wide Nose.—This type of nose is due to a spreading of the nasal bones at their outer edges, or to a thickening or spreading of the ascending processes of the superior maxilla. The latter processes are practically a part of the nasal bones, and continue the plane of the latter back to the face.

The steps of the operation for correcting an abnormally wide nose are the same as those employed for the correction of lateral deformity by the external method. (See page 64.) The nasal bones are first chiselled free, and then the inner edge of the ascending process of the superior maxilla is also chiselled off on both sides. The loose bones are now moulded toward the middle line and held in place by a tin cap. After twenty-four hours this is replaced during the day by the mask splint. If the bridge of the nose, as well as the base, is wider than normal, a strip of bone is taken out of the middle line through a small incision at the lower end of the nasal bones.

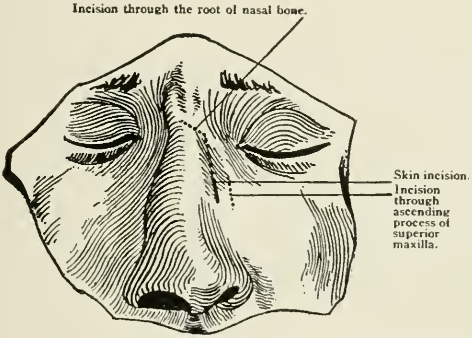
Incision through the root of nasal bone.
Skin incision.
Incision through ascending process of superior maxilla.

Fig. 61.—Diagram to Illustrate the Correction of Lateral Deformity of the Nose by the Direct Method. (Original.) Dark line indicates the incision in the skin; the dotted lines the bone incisions.

d. The Nose with the Drooping Tip.—Now and then the tip of the nose is redundant and curves downward and backward so as to hang over the upper lip. I have had no experience in correcting this deformity. Ballenger, who operated in one case of this nature, describes the operation in the following manner: From the anterior part of the cartilaginous septum he removed, by submucous resection, a triangular piece of cartilage. The base of the triangle was the cartilaginous bridge. When the cartilage was removed it allowed the tip of the nose to be pushed upward, in which position it was held by adhesive plaster. The redundant skin of the tip gradually retracted, and the end of the nose remained in the corrected position. Dr. D. C. Green is at present developing, for the correction of the drooping tip, an operation which promises well. It consists in making a chamber between the two layers of the mucous membrane of the septum under the tip, and then removing from the posterior part of the septum, by the submucous method, a large piece of cartilage. This is put in warm salt solution and trimmed into the proper shape. Then it is placed in the chamber in the anterior part of the septum. Experiment has proved that this piece of cartilage will live and will support the tip.

Deviations of the Septum.—There are two chief causes of deviations of the nasal septum: asymmetry of growth, and trauma. Occasionally the asymmetry occurs between the two halves of the head, but, as a rule, it is confined to the bones which bear the teeth. Unequal descent of the second central incisors and unequal descent of the antra, the two most important forms in which this asymmetry shows itself, cause a large percentage of spurs and deviations of the septum. Trauma may act in connection with these two causes or may act alone.

Classes of Deviations.—The upper border of the vomer is the weak line of the septum. Most of the deviations due to asymmetry of growth have this line for their long axis. In such deviations the axis is horizontal. The septum folds upon itself as the fingers close upon the upright palm. The other deviations have their own axis, roughly speaking, vertical. Such deviations are usually due to trauma. They are found in the anterior part of the quadrangular cartilage just within and blocking the vestibule. The cartilage bends upon itself and makes a sharp rectangular knuckle.

Treatment of Deviations of the Septum in General.—The best operation for deviations of the septum is the resection of the deformity submucously. In theory the operation is simple, but in practice it is almost always long and often very difficult. The basal idea of the operation is to make an incision on one side of the septum, through the mucous membrane, down to the cartilage, and then to separate the mucous membrane from the surface of the cartilage involved in the deviation. After the mucous membrane has been elevated from one side of the septum, it is then elevated from the other by making an incision through the cartilage to the under surface of the opposite mucous membrane, but not through it, and raising this mucous membrane without perforating it. When the mucous membrane is elevated from the two sides of the septum over the deformity, the loosened mucous membrane is held away from the septum with an appropriate speculum, and the cartilage and the bone of the septum are removed wherever they are out of line. With the deviation removed, the two sheets of mucous membrane fall together, and are held in position for a day or two until they reunite. The aim of the operation is to work through as small an incision as will permit the removal of the deformity, and to save the opposite mucous membrane intact. The danger of the procedure is that the second mucous membrane will be perforated, and that the opening will come opposite the incision in the first one—the result of which will be a perforation. If a perforation occurs in the anterior part of the mucous membrane, the patient may make a whistling noise when he breathes, or there may be annoying scabbing about the hole. A perforation in the posterior part of the septum amounts to but little, except that it shows that the technique of the operation was defective. No matter how much care may be exercised, a perforation is likely to occur in a small percentage of cases. Perforations occur oftenest when the operator attempts to hurry in order to make the operation spectacular. The operation is suited to all classes of deviations.

Age at which the Operation Can Be Done.—The operation can be performed at any age when obstructive symptoms show themselves. Until the period of growth is well over—that is, until fifteen years of age—it is probably better to remove only as much of the septum as is actually obstructing.

Submucous resection of septal deformities has now been performed long enough to show that extensive removal of the septum does not weaken the bridge of the nose. Experience has shown also that a nose which has been so operated upon will withstand very considerable trauma without any evil consequences. In many cases, after the removal of the cartilage, the septum seems to stiffen as if new cartilage or new fibrous tissue had been formed.

Details of the Operation.—*Anæsthesia.*—Nervous patients and children should be operated upon under general anæsthesia. In most cases, however, cocaine anæsthesia is employed. Some operators use cocaine crystals pure and produce anæsthesia by rubbing them over the mucous membrane. I cannot persuade myself that this is safe. Perfectly satisfactory anæsthesia can be obtained by swabbing with a ten-per-cent solution of cocaine mixed with adrenalin-chloride solution of full strength. The adrenalin seems to counteract the depressant effect of the cocaine, so that a cocaine solution of the strength named can be used freely throughout a long operation. It is a good plan, in the interval of ten minutes or more during which the instruments are boiling and the operating table is being spread, to put a cigarette of cotton (saturated with the cocaine-adrenalin solution) in either nostril of the patient, so that, by the time the operator is ready to start, the mucous membrane is completely blanched.

Position of the Patient.—The patient can be operated upon in the sitting or in the half-sitting position. The half-sitting position upon the usual adjustable operating table is the best for most cases. The patient in the half-sitting position is much less liable to faint. With the patient sitting half upright, the operator sees the upper part of the septum better than the lower part. If, therefore, there is a large basal spur, it is better to seat the patient fully upright while work is being done upon the lower part of the septum.

Illumination.—Reflected light from the head mirror will answer for the anterior part of the septum, but this will not illuminate the posterior part as well as the Kirstein forehead light. If the forehead lamp is used throughout the whole of the operation it gets very hot. Good light is essential because the eye speedily becomes very tired. There is no operation which is more fatiguing both for the operator and for the patient, so that anything which will shorten it should be procured and used. For shortening the operation, an assistant is of the greatest service. He can swab and retract the alæ when necessary, and can use the mallet if the operator wishes to employ the chisel for the removal of a basal spur. It helps greatly also to have some fifty swabs previously made up. The swab handles can be of metal or of wood. If they are of wood, there is no necessity for saving them. An adjustable instrument table, which can be placed over the patient's chest, and upon which are arranged the instruments in active use, serves to keep the instruments from falling upon the floor, as they are prone to do if they are placed upon the breast of the patient.

Length of the Operation.—An hour is a short time for the correction of an extensively deviated septum. More often the time is an hour and a half or even two hours.

The Side of the Nose in which the Operation Is Carried Out.—Most operators make the initial incision through the mucous membrane in the nostril where the convexity of the deviation occurs. Since the majority of operators are right-handed, if the convexity of the deviation is slight and is situated in the left nostril, it is still the better plan to work from the right nostril.

The Forms of the Incision through the Mucous Membrane.—There are two forms of incision through the mucous membrane: the buttonhole incision, and the flap or T-shaped incision. The buttonhole incision is best adapted to deviations which have gradually sloping sides, and in which the concavity does not make a marked V, and the convexity is not crowned by a large or sharp spur. The more experience the operator acquires, the more he can do through the buttonhole incision. Some operators pride themselves on the fact that they use this form of incision to the exclusion of any other. This is poor practice for the beginner, and often it is not worth while for the older operator to adhere too closely to one form of incision. Time can be saved and many perforations avoided if the flap method of making the incision is employed in all cases of large spurs with deviations, as well as in other cases in which difficulty is experienced in separating the mucous membrane or in which the mucous membrane is found to be very thin. The operator never should wait until he is tired and nervous before obtaining sufficient operating room by enlarging his incision. The great majority of perforations are made, at the end of the operation, by a tired operator working in too narrow a space.

Instruments.—A bewildering number of instruments have been invented for this operation. In reality, but few instruments are necessary. Naturally, some of these are of special pattern. After a short time every operator finds out what instruments best suit his hand and his method of working. The essential instruments are a short knife, an elevator for raising the mucous membrane, a long-bladed speculum, a thin-bladed conchotome for dividing the cartilage, a thick conchotome or punch for work upon the bone, and a small chisel with a long handle.

The following special instruments are the ones used by the writer: The Allen-Heffernan self-retaining wire speculum, the author's adjustable wire speculum (Figs. 62 and 63), Ballenger's swivel knife, Jansen's thin-bladed forceps, Freer's bone-punch and one of his small rectangular knives, and the Killian bent needle. There are many forms of elevators. The operator gets used to one kind and generally keeps to that. It is essential that the elevator should not be too small, and, especially, that it should not be small and at the same time pointed. I use almost entirely a small dermal curette.

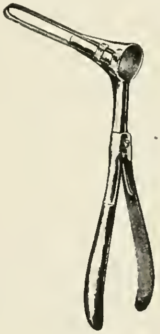

Fig. 62.

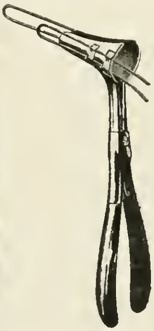

Fig. 63.

Fig. 62.—Author's Adjustable Wire-bladed Speculum, for Submucous Resection of the Septum.

Fig. 63. Author's Adjustable Wire-bladed Speculum, showing manner of adjusting the blades.

General Remarks.—It should be remembered that the mucous membrane over the summit of the convexity of the deviation or over the crest of a spur is very thin and most easily perforated at these points. The mucous membrane is firmly adherent to the periosteum beneath it, and can be separated from it only with difficulty. The mucous membrane and the periosteum can be readily separated from the cartilage if the periosteum is completely cut through and the elevator is carried back between the periosteum and the cartilage or bone. In the small piece of fleshy septum which makes the tip of the nose below the anterior edge of the quadrangular cartilage—the subseptum, as it is called—it is hard to get the periosteum, or rather the perichondrium, to peel from the cartilage. Perhaps the most common mistake made by operators is not to cut through the perichondrium completely, and to begin the elevation of the mucous membrane supposedly from the cartilage, but in reality from the perichondrium. Whenever the elevation of the mucous membrane goes hard, the operator should make sure that the elevator is between the cartilage and the perichondrium, not between the perichondrium and the mucous membrane. The object of the operation is to obtain free breathing, not to secure an ideally straight septum. Operations are often needlessly prolonged in order to obtain a pretty result. Remove the amount of cartilage that obstructs, and then stop.

The Buttonhole Incision.—The buttonhole incision is best adapted for symmetrical deviations not crowned with spurs. The more anterior the location of the deviation, the easier is it to remove the projecting portion through this form of incision.

FORMS OF DEVIATION OF THE SEPTUM.—*a. Deviation of the Anterior Edge of the Quadrangular Cartilage.*—In this deformity the anterior edge of the quadrangular cartilage is seen projecting into the vestibule to one side of the median line. Often the tip of the nose is slightly displaced by the cartilage to the other side.

Operation.—The tip of the nose is strongly displaced to one side, so that the edge of the deviated cartilage stands out prominently. An incision half an inch in length is made along the edge of the cartilage, through the mucous membrane and down to the cartilage. Then the mucous membrane is elevated from both sides of the cartilage well beyond the deviation. If difficulty is experienced in elevating the mucous membrane, the perichondrium should be loosened with a few touches of the knife. When the separation is completed the mucous membrane is held away from the cartilage by slipping the blades of the wire speculum through the incision, one blade on one side of the cartilage and one on the other. The blades of the speculum are then spread and the mucous membrane is thus kept out of the way, so that the cartilage can be removed with the Jansen forceps or the swivel knife. When a sufficient amount of cartilage has been removed, the mucous membrane is allowed to fall back into place, and the incision is closed with one or two horsehair sutures. Both sides of the nose are packed with cigarettes of cotton wrapped in Cargile membrane. Both nostrils are packed, in order to hold the two sides of the mucous membrane in contact, and thus to prevent the formation of a hæmatoma between them. The packing on the side which has not been operated upon is taken out in twenty-four hours, while that on the other side is allowed to remain for forty-eight hours. Aside from the removal of the stitches, there is no after-treatment beyond the mere act of swabbing out the nose from time to time. Healing is usually complete by the end of a week. It takes about two or three weeks, however, for the tissues to shrink into their final shape and position.

b. A Symmetrical Deviation Not Involving the Anterior Edge of the Quadrangular Cartilage.—The majority of deviations do not extend to the anterior edge of the quadrangular cartilage, but are situated just within or beyond the vestibule.

They include the posterior two-thirds of the cartilage, and extend a variable distance over the bony septum.

Operation.—In such cases it is not necessary to make the incision over the anterior edge of the quadrangular cartilage. The incision is generally made about a quarter of an inch back of this point, so that a little of the anterior part of the cartilage is left. Operators are still timid about taking away the cartilage as far forward as its anterior border; they fear that, if they do this, the tip of the nose will fall. The incision, then, in the usual case, is made within the vestibule, just in front of the deviation. The steps of the operation are as follows:—An incision, half an inch in length and penetrating only as far as to the cartilage, is made obliquely upward through the mucous membrane and the perichondrium. This incision should be carried to within a quarter of an inch of the bridge. When it has been completed, the muco-perichondrium should be carefully raised from the cartilage. Whenever difficulty is experienced in elevating the mucous membrane, a few strokes with a small knife are made in order to free it. This elevation or separation of the mucous membrane should be carried on slowly. It often proves to be the longest and the most trying part of the operation. As the elevation of the mucous membrane approaches the summit of the deviation on the convex side, great care should be used, since the mucous membrane at this point is thin and often is adherent. If the deviation is marked it is well not to attempt to elevate the mucous membrane beyond the crest of the deviation until later, when some of the cartilage has been removed. After the separation of the mucous membrane of one side has been carried to the summit of the deviation, the mucous membrane of the other side should be elevated. The opposite mucous membrane is reached by an incision through the cartilage. There is great danger, in making the initial incision through the cartilage, of perforating the mucous membrane beyond. This is a very annoying occurrence, because it is almost always followed by the establishment of a permanent perforation, and a perforation in the anterior part of the septum nearly always causes a whistle when the patient breathes. At the very beginning, therefore, the operator should find out whether the cartilage is thick or thin, and act accordingly. The incision through the cartilage is generally a repetition, in position, size, and shape, of the incision through the mucous membrane. The cartilage is cut partially through with a knife, the incision being made on a slant. Then the remaining part of the cartilage is broken through with a dull elevator or with a small curette, until the opposite mucous membrane is reached. When the initial incision in the cartilage has been completed, the elevator is placed in it and the mucous membrane is slowly and carefully elevated from the off side. The elevator should be held as nearly parallel as possible with the septum. The progress of the work of separation can be felt by the little finger in the nostril, or can be seen by turning the patient's head to one side and looking into the nose. The separation is effected more easily on the concave side of the deviation than on the convex side. When half an inch or so of the mucous membrane on the off side has been elevated, it is time to begin the removal of the cartilage. In the early days of submucous resection of the septum it was the aim of the operator to remove as large a piece of cartilage at one time as possible. The ease with which the swivel knife will remove cartilage was responsible for this feeling. In order, therefore, to remove as much cartilage as possible at one time, the elevation of the mucous membrane was carried far back. To accomplish so extensive a separation of the mucous membrane it was necessary to go over and beyond the summit of the crest of the deviation. The mucous membrane is usually thin at this point and is easily perforated. Then, besides, it is hard to elevate the mucous membrane beyond the summit of the deviation, owing to the fact that the cartilage at this point dips away from the line of the elevator. For these two reasons a very extensive elevation of the mucous membrane, for the purpose of removing a large piece of cartilage, often produces a perforation. It is a good rule never to elevate the mucous membrane beyond the crest of a sharp deviation, but to elevate up to this and then to remove the cartilage to the same point. When this is done the room gained makes it much easier and safer to elevate the mucous membrane at the crest. Beyond the crest, when this plan is followed, the cartilage is again removed, a small piece at a time, until the downward slope of the deviation is reached. Here the separation of the mucous membrane progresses much more easily, and it is safe to elevate over a larger area. As the cartilage and the thin anterior upper border of the vomer are comparatively easy to remove, the deformity of the upper part of the septum should be removed first, and the operator should at once work far enough back to remove the deformity entirely, even if, in doing this, he reaches the choana. If the upper part of the deviation is removed first—in other words, if the easy part of the operation is done first—the hardest part, the removal of the crest of the superior maxillary bone and of the palate bone, will be left for the last—that is, until the greatest amount of room has been gained for working that can be obtained. In working downward toward the crest, as the lower edge of the cartilage is reached, it is often possible to pry the remaining strip of cartilage from its bed in the crest by putting a small elevator or curette under its lower edge and forcing it upward. The separation of the mucous membrane from the two sides of the maxillary crest is the next stage in the operation. This is often difficult to accomplish because the mucous membrane is generally firmly adherent over the crest, and the crest is usually bent sharply to one side. Dissection with a small knife should replace blunt dissection whenever difficulty is experienced in separating the mucous membrane from its attachments. The small knives of Freer are very serviceable for this work.

The elevation of the mucous membrane from both sides of the maxillary crest should be persisted in until the crest is perfectly bare on either side and stands up naked and free. To accomplish this requires time and patience, but this part of the operation must not be slighted. When the maxillary crest is free of mucous membrane for the whole length of the deviation, the crest can be bitten off by a strong punch. The punch does not bite well on the anterior part of the crest; hence, for this, the chisel is often the more serviceable instrument. If the punch or the chisel is not used, the base of the crest can be sawed through with the ordinary nasal saw, and the crest wrenched off with the Jansen forceps. The thin anterior edge of the vomer is readily twisted off. Those operators who make speed a prime requisite are accustomed to wrench out the greater part of the bony deviation. Before this procedure is employed the operator must be sure that the mucous membrane is elevated well beyond the part of the septum to be removed. If the mucous membrane is attached to the fragment which is twisted out, there is great danger that it will tear a large hole in the mucous membrane. It is a fact, however, that the more experienced an operator is, the more often will he be able to resort to this somewhat harsh method of operating, and thus shorten the operation and yet not make perforations. The beginner in submucous resection of the septum should employ this twisting procedure with caution. When, in the progress of the operation, the actual resection of the posterior part of the septum is begun, the patient generally complains of considerable pain. Up to this point, however, there seems to be but little, if any, pain. From time to time, in the course of the operation, the speculum is taken out and the two layers of the mucous membrane are laid together in order to see how much of the obstruction remains. When the operation has been carried far enough to remove the obstruction it may be considered as complete, even if an ideally straight septum has not been obtained. The tendency to keep on beyond this point, for æsthetic reasons, is to be discouraged.

The deviation removed, the blood is swabbed from between the two layers of the mucous membrane and they are approximated. If the initial incision is far forward, a stitch or two of horsehair can be put in with the bent needle. As a rule, this is not necessary, because the packing holds the edges of the incision together sufficiently well. The nose is then packed with cigarettes of cotton or of gauze wrapped with Cargile membrane. As these are inserted the mucous membrane is held in position by one blade of the wire speculum, the other blade being withdrawn. Three cigarettes are all that are necessary for the side that has been operated upon, and two for the other. It is well to pack the off side in order to keep the raw surfaces of the two mucous membranes in contact, so that a hæmatoma shall not form between them. The packing is taken out from the side which was not operated upon at the end of twenty-four hours, while from that upon which the operation was performed it is removed only after the lapse of forty-eight hours. It is very much better that the patient should be in a hospital for this length of time, because during this period there is moderate danger that bleeding may occur. While the nasal packing is in place the patient is uncomfortable and often complains of severe headache. The headache is especially severe and lasting if the resection of the septum has extended high up and well back. An extensive resection of the septum is not an operation that one may do as a routine affair in his office and then send the patient home. Experience has shown that many patients are considerably exhausted by it for several days. It is much better, therefore, to put the patient at once to bed and to keep him there for a day or two, as may seem desirable.

Submucous Resection with the Flap or T-shaped Incision.—If the operator finds that he has difficulty in elevating the mucous membrane, or that the single incision does not allow him to get round a sharp spur readily, he should lose no time in obtaining the necessary amount of space by making an incision which shall run horizontally from the base of the vertical one. Often it is sufficient to carry the horizontal incision only half way back on the spur, the posterior half of the resection being done with both sides of the mucous membrane intact. In those cases in which a long and conspicuous spur crowns the deviation, much time can be saved if the buttonhole incision is given up, and, in its place, two incisions are made—one running horizontally along the crest of the spur, and a second one running obliquely upward from the forward part of the horizontal incision. This last incision, which runs in nearly a vertical direction, is made just in front of the beginning of the spur. These two incisions allow a flap of mucous membrane to be turned up from the surface of the spur. The disadvantage of the flap is that it shrinks and leaves a small line of granulations. To my mind this objection is of little importance. A real disadvantage of the flap is that it makes it practically imperative that the opposite mucous membrane be kept intact. A perforation in the opposite mucous membrane has to be very fortunately placed not to come opposite the long incision made for the raising of the flap. A tear which is opposite this incision becomes the site, ultimately, of a permanent perforation.

Unless I desire to cover up a perforation in the opposite mucous membrane, I do not attempt to keep the flap in a position favorable for healing by placing sutures through it. In the ordinary case the nasal packing holds it sufficiently well. The after-treatment is the same as when the buttonhole incision is used.

Whenever the axis of the deviation is perpendicular and the crest of the deviation is sharp, it is a good plan to make the vertical incision just in front of the crest of the deviation and parallel with it, and to begin the removal of the cartilage by taking out the posterior half of the deviation first; that is, to begin by going downhill instead of beginning at the foot of the hill and going up. By adopting this procedure the operator is working almost parallel with the two layers of mucous membrane instead of working at an angle with them, and he does not have the crest of the deviation to turn. In order to reach the front half of the deviation a basal incision is made running anteriorly, and the mucous membrane is retracted forward. The cartilage is then cut through at the anterior limit of the deviation and removed. By adopting this method I have found it easier, in these difficult cases, to get a good start, and at the same time I have avoided many perforations.

Three points in the operation of submucous resection of the septum should always be kept in mind, viz., to elevate the mucous membrane carefully and thoroughly, to use sharp dissection when blunt dissection fails to elevate the mucous membrane readily, and to re-enforce the vertical incision by a basal incision whenever the vertical incision does not give sufficient room for accurate vision and for a degree of retraction of the opposing mucous membranes that will afford ample space for operating. The vertical incision should be carried well up toward the bridge of the nose. By following this suggestion one may often avoid the necessity of making the horizontal incision. Never prolong an operation simply for the gratification of obtaining a perfectly straight septum. Remove the obstructing part of the septum and stop.

COMPLICATIONS OF OPERATIVE TREATMENT OF DEVIATIONS OF THE SEPTUM.—The first and most common complication of submucous resection is the formation of a hæmatoma between the two layers of the mucous membrane. Packing both sides of the nose generally prevents the production of this lesion. Most hæmatomata do not become infected. A hæmatoma is discovered by noticing that the septum bulges and that the swelling, when touched with a probe, conveys to the hand a sensation of something soft and boggy. When such a swelling is found, the incision in the mucous membrane should be opened and the blood let out. Unless the blood has become infected, it is not necessary to keep the incision open for drainage; if it has become infected, a wick should be used for two or three days in order to provide drainage. An infected hæmatoma gives severe headache and but little, if any, fever. Should there be much increase of body temperature, it would suggest a meningeal infection.

Perforations of the Septum.—The thickness of the cartilage of the septum and the thickness of the mucous membrane should be ascertained at the very beginning of any operation upon the septum, and the operator should use extra care if he finds that both are thin. An idea of the thickness of the cartilage can be gained by feeling of it and by manipulating it; the thickness of the mucous membrane is ascertained when the initial cut is made through it. When the first cut is made through the cartilage in order to gain access to the opposite mucous membrane for the purpose of elevating it, the mucous membrane is occasionally perforated. When this happens, the best thing to do is to make a new incision through the cartilage, a millimetre or two further in, and to leave the cartilage in place at the point of the perforation to act as a cartilaginous stopper. At any point where a perforation is made, it will often be possible to close it permanently if it can be managed, in one way or another, to bring cartilage over the hole. As a rule, suturing a perforation is not successful. The best method of all, where it can be employed, is to suture the intact mucous membrane of the opposite side over the perforation.

Healed perforations which are located in the posterior part of the septum are better left alone; those which are located anteriorly are very hard to close. The method which calls for the simplest technique and probably is as successful as any, is to dissect a large flap of mucous membrane from the lower part of the septum and the floor of the nose and to turn it up and suture it over the perforation.

Sepsis of the Nose after Nasal Operations.—Sepsis of the nose after nasal operations is not so common to-day as it was when the crushing operations for the correction of deformities of the septum were in vogue. Any ragged cut in the mucous membrane of the nose is found, on the second day, to be covered with a closely adhering white membrane. There is swelling of both turbinates proportionate to the amount of trauma inflicted at the operation. If the operative wound does not become infected, this white membrane gradually clears up within four or five days. When, however, it does become infected, the membrane spreads over the turbinates and blocks the nose on the operated side, and an irritating, half-bloody, half-serous secretion runs from the nostril and reddens and excoriates the upper lip. The patient complains of severe headache, and has constitutional symptoms of sepsis which are much like the general symptoms of influenza. Usually there is little, if any, fever. The discharge from the nose may assume a purulent character and have an offensive odor, but this is not usual. After three or four days the sanguineous discharge diminishes, and there is less membrane in the nose. Unless the accessory sinuses become infected—and it is only in rare instances that they do become infected—the virulence of the sepsis is over in a week, and the nasal cavity gradually returns to its normal condition.

The only treatment is to keep the part clean, preferably by daily cleansing with a swab. When the turbinates begin to contract a little, the nasal cavity may be sprayed or the douche may be employed. A warm, alkaline spray, such as salt solution, is the best for this purpose. Great care should be taken not to infect the middle ear by way of the Eustachian tube.

Erysipelas rarely follows an operation on the deeper parts of the nose.

Furunculosis of the Vestibule.—Furunculosis of the vestibule of the nose is an annoying and common form of localized infection. It occurs, as a rule, within the tip or about the inferior margin of the rim of the vestibule. It is started by picking and infecting the nose at these points or by the common practice of pulling out the long hairs which project from the vestibule. In some patients, whenever they yield to the temptation to pull out an unsightly hair instead of cutting it off, a small boil is sure to result.

When the boil occurs within the tip, the nose at the end becomes at once fiery red, swollen, and very tender. The pain and the disfigurement are out of proportion to the trifling character of the lesion. After a few days the boil breaks. With the evacuation of the pus the redness and the swelling subside as rapidly as they came. Sometimes, by means of a small mirror introduced within the vestibule, one may see the head of the boil. When this can be done, it is well to open the boil and thus shorten the course of the disease. It is only in rare cases that the boil points externally on the surface of the nose. When it is situated in the rim of the vestibule it is just as tender and just as painful as when it occurs in the tip of the nose. With the boil in the vestibule the upper lip is much swollen, and the swelling may even extend upon the cheek. The treatment is the usual one of early and free incision.

Nasal Adhesions.—The danger of the subsequent formation of adhesions characterizes all operations upon the interior of the nose. It was a much commoner occurrence in the days of rough operating, but adhesions still form, despite improved modern methods. The irritation of any operative procedure in the nose causes a swelling of the turbinates and a temporary blocking of the nasal cavity. Owing to this blocking the turbinates lie for a time against the septum. If the mucous membrane of the turbinate and that of the septum have both been injured in such a manner that the raw surfaces come together, an adhesion between the turbinate and the septum is almost sure to form. The extent of the adhesion is directly proportionate to the size of the wound in the mucous membrane. A small adhesion rightly placed will block nasal breathing and nullify the good which was expected from the operation. The greatest care, therefore, should be taken to prevent the formation of adhesions.

Some years ago, when the nose was rather freely attacked by the galvanocautery and the nasal saw, adhesions were common and often of large size. Not infrequently the middle meatus was obliterated by the gluing of the middle turbinate to the septum. The inferior meatus suffered even to a greater degree. The employment of hard-rubber splints for holding the corrected septum in line until healing had taken place, and rough packing of the nose with gauze, were also responsible, in not a few cases, for the formation of adhesions between the septum and one of the turbinates. In severe cases of hemorrhage such an accident was, of course, excusable. With modern methods of packing the nose, however, adhesions should be rare.

Treatment of Nasal Adhesions.—The adherent tissues should be divided at the point of adhesion. If the nasal cavity is large, these tissues should be excised. Great care is necessary in doing this, in order that the mucous membrane at the base of the adhesion may be injured as little as possible. Theoretically, if a flap of mucous membrane could be sutured over the septal end of the stump of the adhesion, and another one over the turbinate end of the stump, there would be no chance for the adhesion to re-form. If the nasal cavity is roomy it is possible to accomplish this, but, despite the fact that ingenious instruments have been recently devised for this purpose, the technique of sewing within the nasal cavity requires much practice in order to make the operation successful. In a small nose it is impossible to make good flaps of mucous membrane and to sew them accurately. As the older methods of dealing with adhesions show the difficulties encountered in getting rid of them, I will describe these methods here. In the earliest procedure, the adhesion was cut or excised, as the case might be, and the two ends of the adhesion were held apart by some form of nasal packing. If gauze was used it fastened itself into the raw surfaces, and when it was removed the traction on the tissues simply served to increase the denuded area. When the gauze was left out the adhesion returned, and was usually larger than before. Gauze, therefore, was speedily given up, and in its place a thin strip of rubber or metal was employed. While either of these was in place the adhesion could not re-form, but, if the foreign body was left in too long, it set up a nasal discharge, and was sure to cause ulceration of the mucous membrane in some new place. Consequently, when it was finally removed, even if the original adhesion was cured, which was not usually the case, a new point of adhesion was left. The treatment of adhesions finally became reduced to cutting the adhesion with as little trauma as possible and leaving out the packing. If but slight reaction followed the cutting, a part of the adhesion would fail to reunite. The cutting was then repeated at suitable intervals until the adhesion was done away with altogether.

To-day we have a form of nasal packing which is not irritating, so that an adhesion may be cut or excised, and packing put in and repeatedly replaced, until the mucous membrane has re-formed over the stumps of the adhesion. This form of packing we owe to Cargile. The adhesion is cut or excised and a piece of gauze or a cigarette of cotton is wrapped in Cargile membrane, inserted snugly between the stumps of the adhesion, and left in place for three days. For a period of a few weeks the packing is renewed at intervals until the mucous membrane is thoroughly healed. In a roomy nose this procedure is easy to carry out. In a narrow nose it is better, by means of the submucous operation, to remove the cartilage or the bone from the septum over a generous area about the base of the septal end of the adhesion. If this is done, it is possible, by aid of the packing, to push the mucous membrane of the septum strongly to the opposite side and thus make the nasal cavity, on the side of the adhesion, so roomy that it is necessary to leave the packing in the nose but a very short time.

II. DISEASES OF THE ACCESSORY SINUSES IN GENERAL.*

Preliminary Remarks.—In animals of keen scent the accessory sinuses communicate freely with the nasal cavity and contain fully developed turbinates. In this way the area of the respiratory epithelium is much increased. In the skull of man the sinuses are rudimentary in the sense that they contain no turbinate and no olfactory epithelium, although they are often of large size. All the sinuses are formed in the same way. The nasal epithelium sends out prolongations which burrow into the cartilaginous framework of the bones that form the nasal cavity and there undergo enlargement. The antrum is the first to form, appearing at the fourth month of fœtal life. At birth both the anterior and the posterior ethmoidal cells are present in miniature, and the sphenoidal sinus is just beginning to form. The sphenoidal sinus, however, consists of hardly more than the ostium. The frontal sinus begins to be formed soon after birth. *X*-ray plates show that all the sinuses attain a considerable size much earlier than has usually been taught. When the skull enlarges in order to give room for the second teeth, the sinuses grow much faster. This is especially true of the antrum.

Modern sinus surgery has advanced, owing to a more thorough study of the anatomy of these cavities. A knowledge of the anatomy of the sinuses, therefore, is essential for intelligent work, and for that reason the discussion of the surgery of each sinus is preceded by a statement of its applied anatomy.

Pathology and Etiology.—Diseases of the accessory sinuses are divided into two classes—acute and chronic.

Acute Disease.—Acute disease occurs in but one form, a general inflammation of the mucous membrane of the sinus with an exudation of serum or the formation of pus. It is due to infection from the nose. In many cases it is only an extension of the inflammatory process in the nasal cavity; in other cases it occurs independently of any marked changes in the nose.

Chronic Disease.—Chronic disease is divided into two classes: (1) Cases of chronic retention; (2) cases of chronic suppuration.

Chronic Retention.—Cases of chronic retention are due to mechanical or inflammatory closure of the drainage duct of a sinus. With the duct closed, the vessels of the mucous membrane absorb the oxygen from the imprisoned air. In this way a partial vacuum is produced, and in consequence a hyperæmia of the vessels results, accompanied by the pouring out of an exudate. We have long been familiar with a similar process in connection with the middle ear. The glands of the mucous membrane of the sinus are stimulated and secrete an excess of mucus. When the sinus is full, the pressure of the increasing mucus causes its walls to be gradually absorbed so that the cavity of the sinus progressively enlarges. A sinus filled with imprisoned mucus is called a mucocele. Mucoceles are most common in the ethmoidal labyrinth. When an ethmoidal mucocele has used up its available room, it may break into the frontal sinus, and from here appear on the brow, or it may invade the orbit and push the eye aside. As a rule, such a mucocele points above the inner canthus. Mucoceles may attain very great size if the retaining skin does not give way or if a drainage opening into the nose does not become established. The contents of a mucocele are usually sterile.

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* The material for this paper has been drawn from the books of Sieur and Jacob, Hajek, Killian, and Zarniko, from a paper by St. Clair Thompson, and from the writer's personal studies. The drawings not credited to others were made by the writer from his own specimens. All such specimens are from the Anatomical Laboratory of the Harvard Medical School, and all anatomical investigations were carried out in this laboratory.

Chronic Suppuration. During the course of a mucocele the mucous membrane of the sinus is gradually destroyed by the increasing pressure. Occasionally, in cases which give the characteristic picture of a mucocele, the ethmoidal labyrinth or the frontal sinus is found to be filled with disintegrated fluid blood or with blood coagulated into a jelly-like mass. The microscope shows this to be blood and mucus, and the material on examination proves to be sterile. Such haematoceles were probably originally mucoceles, in the progress of which an opening became established in some vessel of the mucous membrane or the bony wall of the sinus. Such a haematocele may involve the frontal sinus alone or both the ethmoidal labyrinth and the frontal sinus. How soon in its course a mucocele may be converted into a haematocele we do not know. There is no reason why it should not occur quite early. After it has occurred, the blood offers a splendid culture medium for the abundant bacteria which are close at hand in the nose. Thus, many cases of chronic suppuration in the accessory sinuses are simply infected mucoceles. The majority of cases of chronic suppuration, however, are due to direct infection of the mucous membrane lining these sinuses, the infection finding its way from the nose through the drainage duct. In these cases the drainage duct is seldom completely blocked, so that this type of case, unlike the mucocele, is characterized by the presence of pus in the nasal cavity. The partial retention of the pus gives rise to marked pain. In long-standing cases of chronic suppuration in the accessory sinuses the mucous membrane becomes œdematous and finally polypoid. In certain instances the mucous membrane is replaced by fibrous tissue; and this fibrous tissue may even ossify.

Where pus is escaping under pressure of the wall, is thenus will be found necrotic at the point of escape. In cases of mucocele the front wall and the floor of the frontal sinus undergo softening and thinning until they disappear. The same thing happens to the lachrymal bone and to the os planum. The inner wall of the ethmoidal labyrinth—*i.e.*, the portion constituted by the superior and the middle turbinates—is, for some reasons, more resistant. In both acute and chronic disease of the sinuses the cavity of the sinuses may become filled with cheesy material. Cases of chronic disease of the sinuses have been reported in which the contents of the sinus were serous. Here again the likeness to certain affections of the middle ear is striking. As a rule, however, in chronic cases the sinus is filled with pus.

When noticeable disease of the walls of a sinus is found, the primary disease usually is of either a tuberculous or a syphilitic nature.

Syphilis of the Accessory Sinuses.—A certain number of acute cases of sinus disease are due to syphilis; more often, however, syphilis leads to chronic disease. The two sinuses oftenest affected are the ethmoidal labyrinth and the frontal. In the secondary stage of syphilis there is at times an involvement of the periosteum of one or of all of the sinuses. The antrum is involved less often than the frontal sinus and the ethmoidal labyrinth. In late syphilis both periostitis over the frontal bone, and gumma, have often been observed. Gumma of the ethmoidal region also occurs and may be bilateral. It may simulate closely mucocele of the ethmoid, and give the characteristic tumor of mucocele above the inner canthus of the eye. As is the case in mucocele, there may be no signs of disease in the nose. Osteomyelitis of the superior maxilla and of the frontal bone occurs in tertiary syphilis. In one case of undoubted late syphilitic disease, which recently came under the writer's notice, the sphenoidal mucous membrane was covered thickly with granulations, and the cavity of the sinus was filled with foul pus. In all cases of sinus disease, therefore, syphilis should be ruled out at the start. If this cannot be done, a short and vigorous treatment for syphilis should be carried out.

Tuberculosis of the Accessory Sinuses.—If there is any pronounced history of tuberculosis in the patient's family record, or if the age or the general appearance of the patient suggests that he may have this disease, the tuberculin test should be tried. If the case prove to be one of tuberculosis of the sinuses—and I believe that the future will show that the number of such cases is larger than we have hitherto supposed—the use of tuberculin would be a valuable therapeutic agent in connection with the usual operative measures.

Symptoms and Signs of Disease of the Accessory Sinuses.—One-sided Nasal Discharge or Nasal Pyorrhœa.—Pus in the nose is the cardinal symptom of disease of the accessory sinuses. The discharge is one-sided. The presence of a foreign body in the nose, especially if the patient is a child, should first be ruled out. So also must the presence of malignant disease. These two things having been disproved, one-sided nasal discharge speaks for disease of the sinuses of one side, while pus from both nostrils speaks for disease of the sinuses of both sides of the head.

Pus in the Middle Meatus.—Pus in the middle meatus is another of the chief signs of sinus disease. The frontal sinus, the anterior ethmoidal cells, and the antrum drain into the middle meatus. By day pus from the middle meatus drops to the floor of the nose; by night much of it runs back over the soft palate into the pharynx. Pus from the posterior ethmoidal cells and from the sphenoidal sinus fills the olfactory fissure and then follows the septum to the floor of the nose. Most of the pus from the sphenoidal sinus flows down to the top of the choana, and from here to the back and sides of the pharynx. From the pharynx it may reach the larynx or the bronchi. The greater part of it, however, is either spit out or swallowed.

POLYPI IN THE MIDDLE MEATUS.—The presence of pus in the middle meatus causes the growth of polypi. At times fibrous excrescences are found instead of polypi.

MALODOROUS DISCHARGE.—A one-sided malodorous discharge may be due to a foreign body in the nose, to syphilis, to a syphilitic sequestrum, or to atrophic rhinitis. The antrum gives a foul discharge oftener than does either of the other sinuses.

HEADACHE.—Headache is one of the prominent symptoms of sinus disease. In acute affections of the sinuses it is very severe. As a rule, it is severe also in chronic cases, but not so tumultuous as in the acute cases. In some chronic cases, however, there is no pain. It is not possible in all instances to locate the diseased sinus by the seat of the pain. Generally the pain of a diseased frontal sinus is located over the brow, while that from a sphenoidal sinus is located in the occipital region. The pain from an antrum is more often over the brow than over the affected antrum. A frontal sinus, however, may cause pain in the occipital region, and a sphenoidal sinus may cause pain in the frontal region. Finally, the pain may be most severe on the side opposite to that of the diseased sinus.

NEURALGIA.—Since the branches of the great fifth nerve run in close connection with the walls of the various sinuses, neuralgia of its different branches is often one of the most distressing symptoms of sinus disease. In every case of trifacial neuralgia the condition of the sinuses should be carefully determined.

DISTURBANCES OF VISION.—Ethmoidal disease is liable to cause a diminution of vision. In all cases where failure of vision cannot be accounted for, the ethmoidal region should be investigated. When the eye is pushed aside by pus breaking into the orbit from the frontal sinus or from the ethmoidal labyrinth, naturally double vision results. Disease of the sphenoid also gives a disturbance of vision.

DISTURBANCES OF SMELL.—Owing to the closure of the olfactory fissure by swelling, by polypi, or by pus, the sense of smell is either diminished or lost. The loss of smell in some cases is due to the destruction of the olfactory epithelium. It is characteristic of disease of the antrum, especially, that the patient is at times conscious of a bad odor, but the odor is not usually perceptible to the people about the patient. Just the reverse is true in ozæna.

CHRONIC PHARYNGITIS AND LARYNGITIS.—The pus streams down the posterior pharyngeal wall, and crusts and dries there, setting up a chronic inflammation of the mucous membrane. The pus also drops into the larynx and lies on the vocal cords or in the interarytenoid space. The inflammation which is thus set up in the larynx may extend to the trachea and the bronchi.

Chronic Gastritis.—In certain cases so much pus is swallowed that it leads to indigestion. The absorption of the ptomaïns of the pus produces a marked diminution in the patient's nutrition.

Epistaxis.—The pus becomes converted into scabs and crusts in the nose; and when the scabs are removed, epistaxis often follows.

Mental Depression.—In ethmoidal disease, especially, the patient is mentally depressed, and his ability to work is lessened.

Tenderness on Pressure.—In disease of the antrum, tenderness on pressure is often present over the cheek or in the canine fossa. In frontal disease there is tenderness over the brow and at the inner angle of the floor above the lachrymal bone. In testing for this, the supra-orbital nerve must be avoided. In ethmoidal diseases there is tenderness above the inner canthus of the eye, over the lachrymal bone. Both frontal disease and disease of the antrum may give tenderness at this same point. In ethmoidal disease there is not only tenderness on pressure, but also a subjective feeling of pressure over the root of the nose.

Changes in Body Temperature.—In acute cases there may be fever. It should, however, be temporary. In chronic cases fever is not usually present unless an intracranial complication has set in.

Complications.—The complications of sinus disease are either orbital or intracranial. Pus may break into the orbit from the ethmoidal labyrinth or from the frontal sinus and push the globe of the eye to one side. In posterior ethmoiditis the optic nerve may become so seriously involved as to lead to blindness. A gradual and partial loss of vision is more common than a total loss. Rarely, disease of the frontal sinus causes an abscess of the frontal lobes of the brain. Meningitis may arise from disease of the frontal sinus, but it is not common. Meningitis is more common after acute inflammation of the ethmoidal labyrinth or chronic inflammation of the sphenoid. Suppuration in the sphenoidal sinus is a treacherous affection and liable to result in a basal meningitis. Sphenoidal suppuration can indirectly cause a mastoiditis by infecting the cells in the basilar process and in the condyles of the occipital bone, the latter cells in turn infecting those of the mastoid process. The intracranial complications of sinus disease are generally fatal.

Combined Empyemata of the Accessory Sinuses.—Very often two or more of the accessory sinuses are diseased at the same time. From the position of the ethmoidal labyrinth it would seem that infection could radiate most easily from this and so be responsible for the majority of the cases of combined empyemata. Statistics, however, do not bear this out. They show that the commonest sinuses to be diseased conjointly are the antrum and the sphenoid, then the frontal and the antrum, and finally the ethmoidal labyrinth and the frontal. These statistics were made before the days of the *x*-ray and the modern radical operations on the sinuses. In the writer's experience it is unusual to find the frontal sinus diseased without having at the same time disease of the anterior ethmoidal cells. The antrum is the natural reservoir for the frontal sinus and the anterior ethmoidal cells, so that an antrum operation is practically always necessary in chronic disease of the frontal sinus.

Symptoms.—The symptoms of combined empyemata of the sinuses are simply a combination of the symptoms of disease of the separate sinuses. These symptoms have already been given.

Diagnosis.—METHODS OF EXAMINATION.—The nasal cavity should be carefully cleaned. When this has been done, it will be an easy matter to recognize the presence of a foreign body, a new-growth, or a sequestrum resulting from syphilitic disease. Tuberculosis also can be recognized. The presence of one-sided nasal polypi speaks for a suppurating focus in the near neighborhood. As a rule, the polypi spring from the middle meatus.

The next step in the examination is to clean out the polypi and to see if their thorough removal exposes to view the suppurating focus. While this is going on, or even before anything is done, transillumination should be tried for the antrum and the frontal sinus, and an *x*-ray plate should be taken. It should be a rule to take an antero-posterior plate and two lateral plates, all three of them being needed in order that one may form an opinion of the true state of affairs. The taking of the plates should be repeated until clear ones are obtained. No judgment should be made from a dim plate.

The polypi having been removed and the anterior end of the middle turbinate having been taken away, the various sinuses should be probed in order. In a case of empyema of the accessory sinuses the pus immediately reappears after it is wiped from the nose. It should be remembered that pus in the middle meatus may come from the frontal sinus, the antrum, or the anterior ethmoidal cells, whereas pus in the olfactory fissure comes from the posterior ethmoidal cells or from the sphenoid. By probing, one may often localize the particular sinus from which the pus comes. The sinus supposed to be affected is then washed out by catheterizing the natural opening or (when this is possible) by puncturing the sinus wall. If the water which escapes during the washing of a suspected sinus is clear, the supposition is that that sinus is not diseased. The sinus next in order should then be investigated.

STOPPING OFF A SINUS. The sinus is washed out, and then its opening in the middle meatus is stopped with cotton. Later, the cotton plug is removed and the sinus rewashed. In practice, this is hard to carry out precisely. A good *x*-ray examination will give the desired information much more quickly.

In every case of sinus disease it is desirable to settle first whether the antrum has pus in it or not, since the antrum is the sinus most frequently diseased. Examine the antrum again, even if it has been examined by a colleague and pronounced healthy. If the antrum is diseased, wash it out and clean the middle meatus. In a short time, if the middle meatus fills with pus again, either the frontal sinus or the anterior ethmoidal cells are involved. In deciding which of these regions is at fault, Killian's speculum is of great use. By means of this we can examine the posterior cells of the anterior group, and also at times the opening of the frontal sinus. Wherever pus is found it is necessary to determine whether it is produced at the spot where it is seen or whether it comes from some more remote region and is merely lying at this spot as in a receptacle.

Pus in the neighborhood of the posterior ethmoidal cells calls for investigation of the sphenoidal sinus and of the posterior ethmoidal cells. In this examination the sphenoid is opened first. During this operation the patient should lie on his back or sit with the head bent forward. If the pus in the olfactory fissure, after being wiped away, soon reappears, there is present a combined empyema of the sphenoid and the posterior ethmoidal cells. If the ostium of the sphenoid is plugged with cotton, and the cotton becomes moistened with pus, there is disease in the sphenoid. The cotton remains dry if the disease is in the posterior ethmoidal cells. Many sittings, which try the endurance of the patient and the operator, are often necessary before a certain diagnosis can be arrived at. The *x*-ray often will shorten the exploratory procedures. A plate, therefore, should be taken early, in order to spare the patient as much as possible.

Treatment of Sinus Disease in General.—The treatment of sinus disease is divided into palliative treatment and operative treatment. In palliative treatment the sinus is simply washed out, while in operative treatment the sinus is opened surgically. In chronic diseases of the accessory sinuses palliative treatment is tedious and very uncertain in its results. In considering the form of radical treatment which is to be advised, one should weigh very carefully the amount of deformity which will result from the measures that may be adopted. Many patients rightly prefer freedom from pain, a moderate amount of nasal discharge, and no deformity, to absolute cessation of the discharge and very marked deformity.

If a radical operation is decided upon, the fronto-ethmoidal operation will accomplish more than any other. The operation requires about two hours to perform. If both sides of the head are diseased, one side is done at a time.

The Opsonins.—The value of opsonic treatment in chronic disease of the accessory sinuses has not been tried sufficiently as yet to establish its value. Theoretically, it should be of service if combined with operative measures, especially where an attempt is made to obliterate a sinus.

Prognosis.—Acute inflammation of the various sinuses has a marked tendency to get well. Chronic inflammation, on the other hand, has a long course and is often rebellious to treatment.

III. THE APPLIED ANATOMY AND THE DISEASES OF THE ETHMOIDAL CELLS.

Anatomy.

The ethmoidal labyrinth lies at the summit of the nasal fossa, to the inside of the lachrymal bone and the os planum. It consists of some ten small air cells which drain into the upper part of the nose. Together they form a wedge-shaped mass. The base of this is placed posteriorly and is made by a part of the front wall of the sphenoid. The apex is situated anteriorly and on a line with the anterior limit of the lachrymal bone. (Fig. 64.) The sides of the wedge are made as follows: The upper side or wall is made by the floor of the anterior fossa of the skull; the outer wall by the os planum and the lachrymal bone of the inner wall of the orbit; the lower wall by the superior wall of the antrum. The inner wall is free in the upper part of the nasal fossa, is placed parallel with the septum, and is separated from it by a groove called the olfactory fissure. From the inner wall spring the middle, the third, and the fourth turbinates. The inner wall, therefore, is crossed by the middle, the third, and the fourth meatuses. Behind the labyrinth and connected with it by a common wall is the sphenoid; above and anteriorly, and often having a wall which is common to both, is the frontal sinus; to the outside and connected with it by a common wall is the orbit. The understanding of these relationships is vital for the proper appreciation of the pathology and the surgery of the labyrinth. The posterior cells of the labyrinth are present at birth, and hence are larger than the anterior cells which appear after birth. The posterior cells often hold from fifteen to thirty drops of fluid, while the anterior ones generally do not hold more than two or three. If the ethmoidal labyrinth is turned into one cavity by breaking down the partitions between the cells, this cavity will hold three drachms. This is twice as much as the normal sphenoid or the normal frontal will hold, and nearly a third as much as will fill an antrum of the usual size.

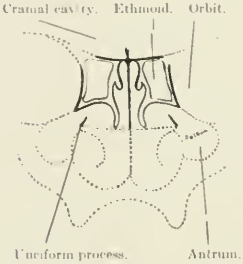


Fig. 64.—Diagram to Illustrate the Chief Relationships of the Ethmoidal Labyrinth. (Hajek.)

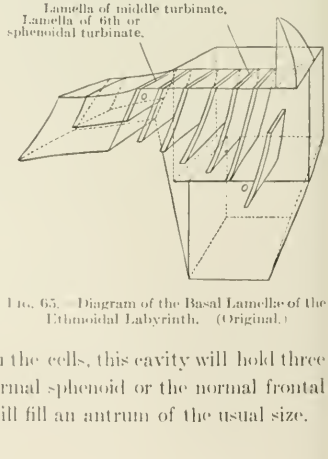

Lamella of middle turbinate.
Lamella of 6th or sphenoidal turbinate.

Fig. 65.—Diagram of the Basal Lamellæ of the Ethmoidal Labyrinth. (Original.)

If the labyrinth is to mean to the operator anything more than an irregular mass of small cells, it is necessary for him to bear in mind the ground plan of the ethmoidal region and to know the grouping of the cells. The ethmoidal labyrinth is composed of seven basal lamellæ. (Figs. 65 and 66.) These run through the labyrinth like beams. They start above, at the cribriform plate, and run obliquely downward and backward, and are roughly parallel with each other. The ethmoidal cells develop in the spaces between the basal lamellæ. The spaces are not entirely obliterated by the cells, so that furrows or meatuses are left between the lamellæ. The turbinates spring from the basal lamellæ. The higher interturbinate grooves vary greatly; the lower ones do not. The fifth and sixth turbinates regularly disappear. In the adult it is equally common to have either three or four meatuses. There are always three turbinates; in fifty per cent of cases there are four. The attachment of the middle turbinate runs diagonally downward and backward across the inner wall of the ethmoidal labyrinth. In front of and below its attachment, and between the body of the middle turbinate and the anterior part of the inner wall of the labyrinth, is the middle meatus. Behind and above its attachment is the third meatus, and in one-half of the cases there is also a fourth meatus. All the ethmoidal cells which open in front of the attachment of the middle turbinate are called anterior ethmoidal cells, and those which open behind it are called posterior ethmoidal cells. The number of the anterior cells varies from five to seven; there are only three or four posterior cells. The latter are often three or four times larger than the anterior cells.

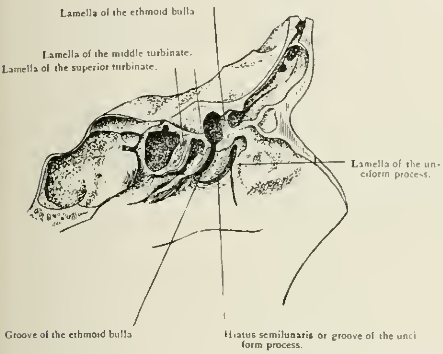

Lamella of the ethmoid bulla
Lamella of the middle turbinate.
Lamella of the superior turbinate.
Lamella of the unciform process.
Groove of the ethmoid bulla
Hiatus semilunaris or groove of the unciform process.

FIG. 66.—Figure Showing the Basal Lamellæ of the Ethmoidal Labyrinth. (Hajek.)

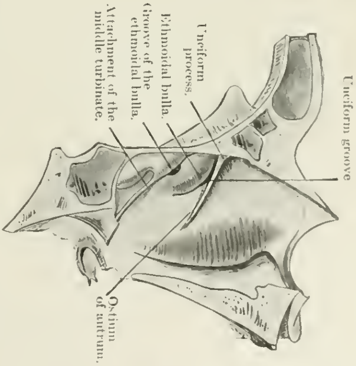

Attachment of the middle turbinate.
Groove of the ethmoidal bulla.
Ethmoidal bulla.
Unciform process.
Unciform groove
Ostium of antrum.

FIG. 67. The Markings on the Outer Wall of the Middle Meatus. (Original.)

THE MIDDLE MEATUS.—In the applied anatomy of the nose the middle meatus is the most important part. (Fig. 67.) The middle meatus is a slit-like space between the middle turbinate and the anterior part of the outer wall of the nasal fossa. The outer wall of the nasal fossa at this point is made by the inner wall of the ethmoidal labyrinth. This corresponds, in the orbit, to the anterior half of the os planum and to the lachrymal bone. The inner wall of the middle meatus is the outer surface of the body of the middle turbinate. By removing the anterior half of the middle turbinate the outer wall of the middle meatus and its markings are disclosed. The chief marking on the outer wall of the middle meatus is a semilunar groove. This is found anteriorly, and is bounded in front by a thin, projecting edge. This is the uniform process of the ethmoid bone, covered with mucous membrane. The uniform process is the first basal lamella of the ethmoidal labyrinth. The groove, called from its anterior boundary the uniform groove (hiatus semilunaris in the older nomenclature), is bounded behind by a prominent pear-shaped swelling—the ethmoidal bulla. Into the uniform groove at its upper part drain the majority of the anterior ethmoidal cells. Into its lower part, hidden by the overhang of the

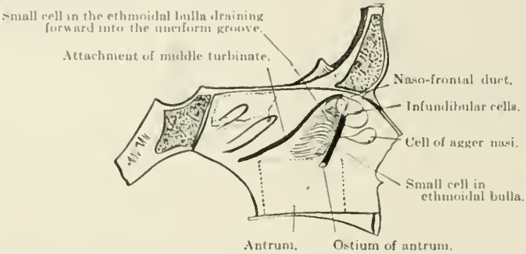

Small cell in the ethmoidal bulla draining forward into the unciform groove.
Attachment of middle turbinate.
Naso-frontal duct.
Infundibular cells.
Cell of agger nasi.
Small cell in ethmoidal bulla.
Antrum.
Ostium of antrum.

FIG. 68.—Diagrammatic Drawing Giving the Arrangement of the Anterior Ethmoidal Cells. (Original.)

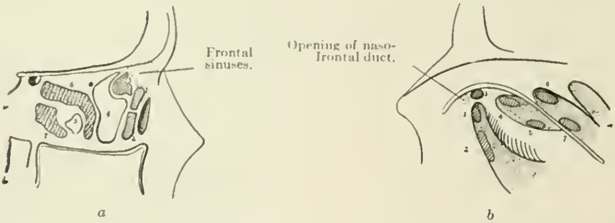


FIG. 69.—The Bases of the Ethmoidal Cells as they Make the Inner Wall of the Orbit. (Sieur and Jacob.)

(a) 1, 2, 3, Cells of the unciform grove. 4, 5, cells of the groove of the ethmoidal bulla; 6, 7, cells of the third meatus.

(b) The openings of the cells figured in Diagram a.

unciform process, opens the ostium of the antrum. In twenty-five per cent of cases the drainage canal of the frontal sinus is continuous with the upper part of the unciform groove. Behind the ethmoidal bulla, and between it and the attachment of the middle turbinate, there is another groove. This is not so well marked as the first one, and not so important. This second groove is called the groove of the ethmoidal bulla. Most of the anterior ethmoidal cells drain into the unciform groove; those which do not, usually three or four cells, drain into the groove of the ethmoidal bulla.

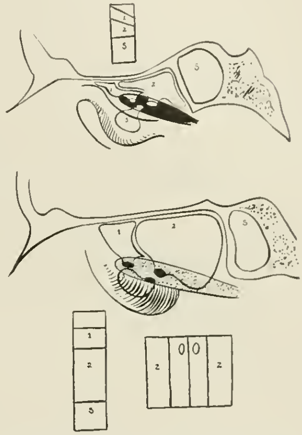


Fig. 70.—Posterior Ethmoidal Cells. (Original.) Drawings from two specimens showing the most common grouping of the posterior cells in cases where the third meatus is the highest.

In the upper small figure, 1 and 2 represent the upper faces of cells 1 and 2 in the larger figure below—that is, the amount of the cribriform plate which roofs over these cells. Letter *S* is the sphenoidal sinus. Of the two lower small diagrams the first one represents the upper surface of the cells 1 and 2 in the large drawing next above. The second of the lower small drawings shows at 2 how the ethmoidal cell farthest back has a common wall with the outer half of the front wall of the sphenoidal sinus. This cell is often called the sphenoidal cell on this account.

On both specimens the middle opening in the third meatus leads to a cell which forces its way through the attachment of the middle turbinate and expands in the lower part of the ethmoidal bulla. Such a cell is found in sixty per cent of specimens.

The Ethmoidal Bulla.—The ethmoidal bulla is developed from the second basal lamella of the ethmoidal labyrinth. Its characteristic pear shape is due to the development, in it, of cells. There are two principal cells in the bulla, an upper cell and a lower. In sixty per cent of cases the inferior cell of the bulla is a posterior ethmoidal cell which has pierced the attachment of the middle turbinate and buried itself in the lamella of the bulla.

The Opening of the Naso-Frontal Duct.—In twenty-five per cent of cases the duct of the frontal sinus opens into the upper part of the unciform groove, and is continuous with it. In fifty per cent of cases the naso-frontal duct opens above the unciform groove and in line with it, but is not continuous with it. In such cases the unciform groove ends blindly in a small pocket or in an ethmoidal cell. In a small percentage of cases the naso-frontal duct opens into the groove of the ethmoidal bulla. (Fig. 68.)

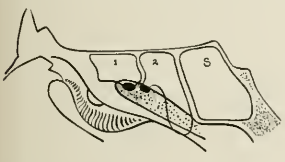


Fig. 71.—Grouping of the Posterior Ethmoidal Cells. (Original.)

In this case the third meatus is the highest meatus. There are but two openings leading from it to cells 1 and 2.

The Anterior Ethmoidal Cells.—In the upper part of the unciform groove there are three accessory turbinates. Between these are developed the greater number of the anterior ethmoidal cells. One of these cells rises higher than the rest and expands, between the two layers of the frontal bone, as the frontal sinus. The remainder of the cells develop below the sinus and around its drainage duct. (Fig. 68.) In the adult there are usually three cells about the upper part of the uniform groove and in relation with the floor of the frontal sinus. These cells are often called the infundibular cells. Half-way down the anterior edge of the uniform groove, in the region of the agger nasi, there is a swelling made by a cell which drains backward into the groove. This is called the cell of the agger nasi. Occasionally there are two cells in this location.

It should be remembered that the roof of these higher cells is made by the floor of the frontal sinus. Therefore they may readily project like mounds into the sinus.

The majority of the anterior ethmoidal cells empty into the uniform groove. A few small cells, the remainder of the anterior ethmoidal cells, drain into the groove of the ethmoidal bulla. Any enlargement of the anterior cells or of the ethmoidal bulla or of the anterior end of the middle turbinate will tend to block the uniform groove and to interfere with the drainage of the frontal sinus, the anterior ethmoidal cells, and the antrum. The middle meatus, therefore, is the most important drainage area of the nose.

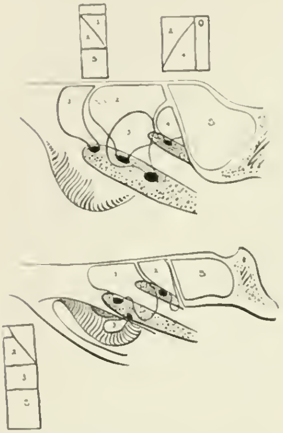


FIG. 72. The Posterior Ethmoidal Cells. (Original.) In both specimens the fourth meatus is present.

In the upper large figure three cells lead from the third meatus and one from the fourth. The front wall of the sphenoid has two posterior cells (2 and 4) one from the third meatus and one from the fourth—taking part in the formation of the outer half of the front face.

In the lower large drawing, but one cell, and that from the fourth meatus, reaches the front wall of the sphenoid. By referring to Fig. 70 the reader will find the explanation of the small diagrams.

THE POSTERIOR ETHMOIDAL CELLS.—In one-half of the cases the third meatus is the highest. (Figs. 69, 70, 71, and 72.) There are usually three openings in the third meatus—an upper, a middle, and a lower opening. The upper opening leads to a cell which ascends to the cribriform plate and reaches outward as far as the os planum. The lower opening leads to a cell which also reaches upward to the cribriform plate, outward to the os planum, and then backward to the outer half of the front face of the sphenoidal sinus. The posterior wall of this cell and the front wall of the sphenoidal sinus are a common partition. The middle opening in the third meatus leads to a cell which, in sixty per cent of the cases, pierces the

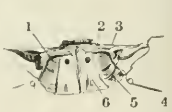


FIG. 73. Drawing of the Front Face of the Sphenoidal Sinus, showing the Relationship between the Posterior Superior Outer Angle of the Ethmoidal Labyrinth and the Optic Canal. (Original.)

1, 5, Common wall between sphenoidal sinus and the ethmoidal cell farthest back; 2, course of the optic canal, 3, lesser wing of the sphenoid; 4, foramen rotundum, 6, inner half of the front face of the sphenoid.

attachment of the middle turbinate and ends in the lower part of the ethmoidal bulla. If this cell does not take part in the formation of the bulla, it runs outward to the os planum in the lower part of the labyrinth.

When there is a fourth meatus there is usually only one opening in it. This opening leads to a cell which runs outward to the os planum, upward to the cribriform plate, and backward to the front wall of the sphenoidal sinus. This cell may be the only one in relation with the front wall of the sphenoidal sinus or it may share this face of the sinus with a cell from the third meatus. If this happens, the cell from the third meatus takes the upper part of the sinus wall, and the cell from the fourth meatus the lower part.

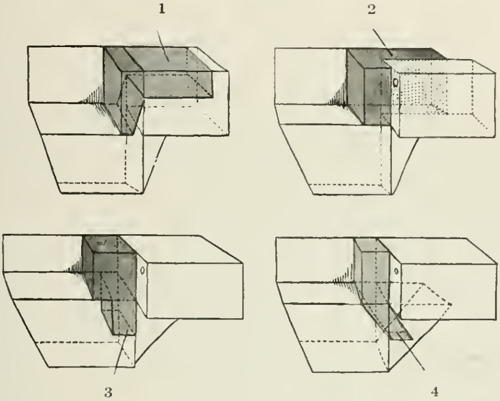


Fig. 74.—Diagrammatic Figure to Illustrate the Variations or Prolongations of the Posterior Ethmoidal Cells. (Original.)

(1) Posterior ethmoidal cell overlying the sphenoidal sinus.

(2) Posterior ethmoidal cell ending in a prolongation which runs to the outside of the sphenoidal sinus. Such a prolongation may be as large as the sphenoidal sinus itself. It is very easy, therefore, to mistake this prolongation for the sinus.

(3) Prolongation of the posterior ethmoidal cell downward into the antrum.

(4) Prolongation of the posterior ethmoidal cell into the pterygoid processes.

The Spheno-Ethmoidal Recess.—Behind the ethmoidal labyrinth and between it and the front face of the sphenoidal sinus there is a vertical groove. This groove is a remnant of the sixth meatus. It is the drainage groove for the sphenoidal sinus. Secretion from the ostium of the sinus is conducted by the groove to the sides of the pharynx.

The Relationship of the Posterior Ethmoidal Cells.—The posterior wall of the ethmoidal cell that lies farthest back makes the outer half of the front face of the corresponding sphenoidal sinus. (Figs. 72 and 73.) When there is a fourth meatus, two cells often share the front wall of the sphenoid, one cell springing from the third meatus and one from the fourth. By destroying the common cell wall the sphenoidal sinus and the ethmoidal labyrinth are made to communicate, and the sphenoidal sinus becomes, for practical purposes, the last one of the posterior ethmoidal cells. That one of the posterior cells which makes the upper part of the front wall of the sphenoidal sinus also makes a portion of the inner wall of the optic canal in which run the optic nerve and the ophthalmic artery. Infection of the posterior ethmoidal cells, therefore, is liable to cause trouble with the eye.

The normal relationship of the ethmoidal cell which lies farthest back with the front face of the sphenoidal sinus is not the only relationship which this cell may have with the sinus. (Fig. 74.) This cell may extend horizontally backward over the sinus so that at first sight the sinus seems to be divided into an upper and a lower chamber. Again, this cell may pass to the outside of the sinus and lie parallel to it for the whole length of the outer wall. Such a cell may be larger than the sinus itself. This extension of the ethmoidal labyrinth is very confusing, because, in operating, it is easy to mistake a posterior cell of this kind for the sinus. The most posterior ethmoidal cell may project downward like a mound into the antrum, almost to its floor. Finally, this cell may run obliquely downward and backward into the base of the pterygoid process.

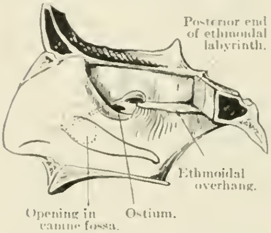


FIG. 75.—Diagrammatic Drawing to Show the Method of Reaching the Ethmoidal Labyrinth through the Canine Fossa. (Original.)

The curette is introduced into the antrum through an opening made in the canine fossa and then passed through the ostium upward into the ethmoidal labyrinth.

In this specimen the ethmoidal cells have been removed, showing how they overhang the antrum.

It is very useful to obtain a clear conception of the size of the whole labyrinth. This is best obtained by turning it into one large cavity by breaking the partitions between the cells. (Fig. 75.) The cavity thus created will hold three drachms—a third as much as the antrum. Posteriorly, the ethmoidal pyramid overhangs the antrum to the extent of a quarter of an inch. The points which it is important to remember about the posterior ethmoidal cells are their large size, their relationship with the front wall of the sphenoidal sinus and the optic canal, and the manner in which a large posterior cell may extend over, around, or beneath the sphenoidal sinus. The great boundaries of the ethmoidal pyramid should never be lost sight of; these are the brain and the frontal sinus above, the eye to the outside, the sphenoidal sinus behind, and the antrum below. With all of these the ethmoidal labyrinth has a common wall. The *x*-ray is the only guide that we have to the size and arrangement of the posterior ethmoidal cells.

Pathology and Symptomatology.

The subjective symptoms of involvement of the ethmoidal cells are frontal headache, a disturbance of vision, and mental hebetude. Profound mental depression, amounting even to melancholia, is due oftener to ethmoidal disease than to disease of any other of the accessory sinuses. There is a feeling of distention at the bridge of the nose. There is a nasal discharge, but it is less copious, as a rule, than when the frontal sinus or the antrum is involved. Anosmia, rather than cacosmia, is complained of. On account of the nearness of these cavities to the optic nerve, disease of the posterior ethmoidal cells causes a greater disturbance of vision than does disease of the anterior cells. In all instances of unexplained trouble with vision, the ethmoidal region should be suspected and good *x*-ray plates obtained.

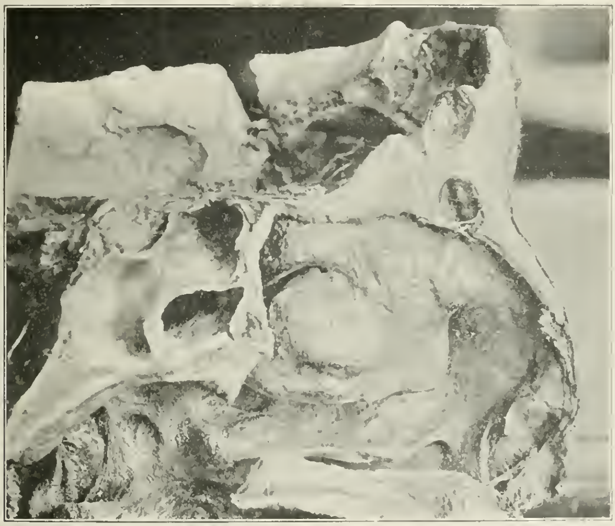


Fig. 76.—Large Middle Turbinate with Cells Developed in It. Large sphenoidal sinus with a posterior ethmoidal cell overlying it anteriorly. (Original.)

In extreme cases the bridge of the nose is enlarged and tender. The lachrymal bone is tender on pressure. The middle meatus is filled with crusts or pus. The pus often works up into the olfactory fissure or drops down over the inferior turbinate to the floor of the nose. The turbinate at times becomes atrophied, so that the nasal cavity has the same appearance that it has in cases of ozæna. In very many cases polypi are present about the middle meatus. Almost always polypi mean that there is an infected focus near at hand. Unless the pus has flooded the middle meatus it is better not to wash out the nose, but to swab away the excess of pus and then to lift the crusts one by one in the hope of uncovering pent-up pus and so exposing the position of the suppurating focus. When, in certain cases, the middle turbinate is forced inward with a probe, pus, which has been dammed up, will escape. All work in the ethmoidal region should be accompanied by careful and repeated probing. Bare bone alone is of little diagnostic value, because the probe easily lifts the mucous membrane from the cell walls beneath; necrotic bone, however, points the way to a suppurating cell.

The anatomical position of the ethmoidal labyrinth exposes it to infection from all sides. It is especially liable to infection from the frontal sinus, so that it is rare to have the frontal sinus diseased without disease also of the anterior ethmoidal cells. It is common also to have the ethmoidal cells and the antrum involved together.

Ethmoidal Cells in the Middle Turbinate.—In nine per cent of cases the middle turbinate contains one or more ethmoidal cells. (Fig. 76.) Such a cell usually opens into the third meatus. A large cell in the middle turbinate may block up the middle meatus. Still larger cells of this kind have been known to reach the inferior meatus and even appear at the vestibule. This condition of the turbinate used to be called "cystic middle turbinate." Moderate degrees of this condition are often discovered in the routine amputation of the anterior end of the middle turbinate. Usually such a cell contains neither serum nor pus, and gives trouble, if at all, by interfering with the drainage of the middle meatus or by pressing on the septum. Such a cell may resist the pressure of a probe or give way and crackle under it. It is possible for such a cell to become infected independently of the other ethmoidal cells and to suppurate. It could hardly escape acting as a reservoir in suppuration of neighboring cells should infection fail to reach it directly.

Disease of the ethmoidal cells may be acute or chronic. Acute disease or inflammation of the ethmoidal cells can be distinguished from chronic disease only by the length of its course. The signs of acute inflammation, therefore, will be discussed under Chronic Inflammation of the Ethmoidal Cells.

Chronic Disease of the Ethmoidal Cells.—1. MUCOCELE.—Mucocele of the ethmoidal labyrinth is due to the retention of mucus within the cells, and the dilatation of the cells from the pressure of the accumulated secretion. A single cell may be involved, or any group of cells. The disease begins, as a rule, in early life, is very slow in its onset, and painless in its course. The end result is that the whole labyrinth is turned into one large cavity. There is no history of a discharge from the nose, and no abnormal secretion is found in the middle meatus. The disease is seldom discovered until the imprisoned mucus begins to make its way to the surface. When this occurs, a small, round, elastic tumor is seen above the inner canthus of the eye. This grows slowly, and gradually pushes the eye to one side. The patient presents himself on account of the tumor and the displacement of the eye.

Diagnosis.—The diagnosis of mucocele is made on the presence of the characteristic tumor and the history of slow painless growth. The *x*-ray shows that the ethmoidal labyrinth on the diseased side is more opaque than that on the well side. Mucoceles are occasionally bilateral, the tumor on the second side appearing a year or two after the tumor on the first side.

If a mucocele becomes markedly infected, stormy symptoms set in. These are pain, fever and chills, and œdema of the lids. The tumor over the inner canthus of the eye becomes red and tender, or there is swelling below or to the inside of the eyeball, showing that the pus has invaded the orbit and has produced an orbital abscess.

Treatment.—If the condition should by chance be recognized before the appearance of the external tumor, intranasal opening of the ethmoidal labyrinth would probably be sufficient to effect a cure. After the tumor appears, only the radical ethmoidal operation by the external or anterior route is of any service. This operation is very simple under these conditions because the lachrymal bone and the anterior half of the os planum have been absorbed, so that a free skin incision, plus the thorough removal of the middle turbinate, is all that remains to be done. Sometimes the floor of the frontal sinus has been destroyed to such an extent that the sinus and the ethmoidal labyrinth are turned into one large cavity.

2. Chronic Suppuration in the Ethmoidal Cells.—In chronic suppuration in the ethmoidal cells pus is seen in the middle meatus. In the same locality polypi also are often found. The presence of polypi in the majority of cases means an infected area which is responsible for their development. In chronic suppuration of the ethmoidal labyrinth the polypi and the atrophy of the turbinates should be regarded as symptoms, not as the primary disease. A diligent search, therefore, should be made for the original focus of the disease, either in the ethmoidal region or in the neighboring sinuses. The *x*-ray shows that the affected ethmoidal region is more opaque than the normal ethmoidal region. Very often the plate shows that the ethmoidal region is not involved alone, but that the frontal sinus or the antrum is also diseased. In such cases it is impossible to say which is the primary seat of the disease. As time goes on, there are discovered fewer cases of disease limited to the ethmoidal region alone. The usual method of making a diagnosis of ethmoidal disease is to find pus and polypi in the middle meatus, then to remove the polypi, and in so doing to open up an ethmoidal cell from which the pus comes.

Treatment.—The first step in the treatment of all forms of sinus disease is the removal of part or all of the middle turbinate. In ethmoidal disease this is done in order to get room for attacking the ethmoidal labyrinth.

The Removal of the Anterior End of the Middle Turbinate.—The middle turbinate and the middle meatus are anaesthetized with a ten-per-cent cocaine solution and shrunk by 1:1,000 adrenalin-chloride solution. The patient is seated and his head thrown upward and backward against a head-rest. When the middle meatus is roomy, the simplest way of removing the middle turbinate is to cut it off with scissors. (Fig. 76.) As a rule, however, the turbinate is taken off in two parts with conchotome and snare. In order to do this, an oblique incision is made with a small straight conchotome upward and backward into the body of the turbinate, as nearly half-way back on the body of the turbinate as the conchotome can be crowded. (Figs. 77 and 78.) Into this incision a small loop of wire is fitted, the cannula of the snare is pushed to the extreme upper edge of the turbinate, and the loop is drawn home. This removes the anterior half of the turbinate. At times the posterior end of the turbinate is bulbous, so that a snare wire can be gotten round it. An attempt should always be made to engage the wire round the posterior end of the turbinate. If it succeeds, the remainder of the turbinate can be quickly removed. Usually the wire loop cannot be made to engage round the posterior end of the middle turbinate; consequently, this part of the turbinate has to be removed with scissors or bitten off with a conchotome or the ring punch. The procedure which has just been given for the removal of the anterior end of the turbinate may be reversed in the following manner: A horizontal cut is made with a conchotome or scissors straight back through the attachment of the turbinate. This is carried parallel with the body of the turbinate as far back as the turbinate is to be removed. A loop of wire is bent at a right angle to the carrying cannula and slipped into the incision in the turbinate. The cannula is held below the turbinate. As the wire is drawn home it cuts downward and removes the anterior end of the turbinate. The posterior half of the turbinate may be freed from its attachment by putting Hajek's hook straight back in the olfactory fissure, to the front face of the sphenoid, then turning the point of the hook outward, and drawing forward. Or the hook may be pushed back between the middle turbinate and the ethmoidal labyrinth, then turned upward and inward, and brought forward through the attachment of the turbinate. A small right-angled knife can be used in the same way. Whatever tags of the turbinate are left are bitten off with the conchotome.

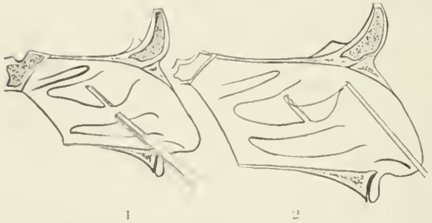


Fig. 77.—The Removal of the Anterior End of the Middle Turbinate. (Original.)

(1) Incision through the body of the turbinate with a small conchotome.

(2) Cannula carrying snare wire in place for the removal of the tip of the turbinate. It is essential that the end of the cannula be pushed well up to the attachment of the turbinate.

The removal of the middle turbinate opens up the middle meatus, gives room for operative manipulations, and allows the sinuses and the ethmoid cells which empty into the middle meatus to drain; but it should always be borne in mind that it does not open up the ethmoidal labyrinth. The ethmoidal labyrinth lies to the outside of the middle turbinate, and to open this a separate procedure is necessary.

Unless the patient is operated upon in a hospital and can stay there for a day, I think it is best to pack the middle meatus lightly for twenty-four hours after removing the middle turbinate. Annoying bleeding is liable to follow if the patient is allowed to move about. Where there is pus in the middle meatus it is very dangerous to leave the packing in place for more than a few hours. Under these conditions most surgeons do not use packing.

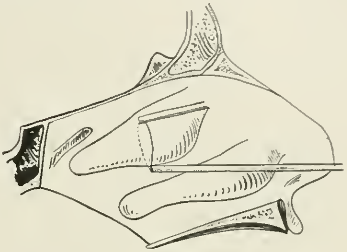


Fig. 78. A Second Method of Removing the Anterior End of the Middle Turbinate with the Snare. (Original.)

In this method the incision for the snare wire is not made from below obliquely upward through the body of the turbinate, but is made from above straight backward through the attachment of the turbinate. The cannula carrying the wire is placed below and parallel with the turbinate. This method is not easy to carry out in a narrow nose.

Trimming the Inferior Turbinate.—The removal of part or all of the middle turbinate is a routine procedure in the treatment not only of disease of the ethmoidal labyrinth, but also in the treatment of disease of the other sinuses. Occasionally it is necessary to trim or to remove a part of the inferior turbinate. It is seldom desirable to remove the whole of it because so much scabbing results from this procedure. Trimming the inferior turbinate is occasionally required in sinus cases in order to give better breathing or better drainage. The method of doing this is as follows: The inferior turbinate is well cocainized both on its inner and on its outer surface. In order to reach the outer side of the turbinate a small swab is rubbed backward and forward in the cleft between the turbinate and the outer wall of the nose. The most satisfactory instrument for trimming the turbinate is a stout, straight saw. The long powerful scissors made for trimming the inferior turbinate cannot be placed accurately, and they usually cut off too much, while small scissors do not get a sufficient hold, and slip. A tampon of cotton or gauze is placed between the turbinate and the septum. Then the saw is placed in the cleft, to the outside of the turbinate, and carried to the attachment of the turbinate, or part way to the attachment, according to how much of the turbinate the operator wishes to remove. When the saw is opposite to the desired place on the turbinate, the blade is turned so as to lie horizontally, with the teeth against the turbinate. The turbinate is now sawed through from without inward until the strip to be removed hangs only by mucous membrane. The mucous membrane which holds the strip is cut through either with the small scissor-punch or with the large turbinate scissors. In a certain number of cases the strip of turbinate is completely detached by this procedure and lies free at the bottom of the nose; and in this event it is grasped with a small conchotome and removed. The detached piece of the turbinate generally eludes the hold of the nasal forceps. Sometimes the patient can blow out the loose piece. As a rule, however, the scissors fail to cut the turbinate completely through at the posterior end. Usually the bleeding makes it impossible to see well enough to place the scissors accurately and to cut the bar of mucous membrane which remains. Sometimes a fortunate stroke with the conchotome will accomplish this, but more often it is necessary to grasp with the conchotome the posterior part of the strip which is being removed and to bring it away partly by tearing and partly by cutting.

The hemorrhage, after trimming the inferior turbinate, is often sufficient to be annoying. On this account the patient, for the first forty-eight hours, should be within easy reach of the physician, preferably in a hospital. When the strip of turbinate has been removed, two cigarettes the size of a small little finger are made of gauze and wrapped in Cargile membrane. These plugs are wetted and placed one on top of the other in the inferior meatus against the cut surface of the turbinate. In order to accomplish this effectively, it is necessary to have the nose clean, to have it well illuminated, and to use a stout pair of forceps like the bayonet forceps. The first plug is crowded down so as to fit snugly along the floor of the nose and beneath and somewhat to the outside of the turbinate. Care should be taken to see that the posterior end of the plug does not ride up and leave the back part of the turbinate unprotected. Bleeding is almost sure to follow if attention is not paid to this point. The first plug inserted, the second one is placed on top of it and carefully crowded down, front and back, the same as was done in the case of the first plug. Above the second plug a piece of unfolded and unprotected gauze is packed in lightly.

If the patient is not to stay in the hospital, he is directed to ride home, and to keep as quiet as possible for forty-eight hours. He should be warned against drinking anything hot. He is told, if bleeding occurs, to sit upright, not to lie down, to apply ice to the bridge of the nose, and to suck bits of ice. If these measures do not speedily stop the bleeding, he should understand that he is to notify the physician. Unless the patient is kept in a hospital, where he can have trained watching, the physician is liable to be summoned needlessly on account of hemorrhage.

The loose piece of gauze and the upper plug are removed at the end of twenty-four hours. Owing to the Cargile membrane, the plug comes away with little, if any, bleeding. The lower plug is taken out at the end of forty-eight hours. After this, no packing is, as a rule, required. For the first four days, whatever cleaning of the nose is necessary should be done by the physician. After this time, the patient can be allowed the use of an alkaline spray made up from

Seiler's tablets or from any similar preparation. Later, an oil spray can be used in addition to the cleansing spray.

REMOVAL OF THE ANTERIOR PART OF THE INFERIOR TURBINATE.—In operations upon the antrum it is customary to remove the anterior part of the inferior turbinate. This is accomplished by making a cut with saw or scissors through the attachment of the turbinate. This cut is carried straight back as far as the turbinate is to be removed, generally to about the middle of the turbinate. When the cut has been made, a loop of wire, bent at a right angle to the carrying cannula, is forced back in it. The cannula is held below the turbinate and parallel with its inferior border. On screwing the wire home it cuts downward and removes the anterior portion of the turbinate. When it is impossible to use the snare, the anterior half of the turbinate should be removed with a punch. But little plugging of the inferior meatus is required after this procedure. The plug need not be carried as far back as is necessary when a strip is taken from the whole length of the turbinate. The plug should be taken out at the end of twenty-four hours, and need not be replaced.

OPERATIONS UPON THE ETHMOIDAL LABYRINTH.

The Intranasal Route.—In slight cases of ethmoiditis, where the only symptoms are a little discharge and a little crusting, all that is necessary for treatment is an alkaline wash. But few cases of this class present themselves. In all other cases the first step is to locate the diseased cell with the probe or by following the pus to its source. In many instances this is a slow procedure. It is necessary to dry the part which is being operated upon carefully and to probe gently and accurately in advance of all further instrumentation. Never work toward the olfactory cleft, but always work upward and outward, toward the orbit. No harm results if the orbit is entered, except perhaps the sudden production of a black eye or an emphysema of the orbit if the patient sneezes or blows his nose. Both of these conditions clear up in the course of a week.

Whenever pus is seen coming from a cell, the cell is opened with hook, curette, or conchotome. Polypi are removed and the cells at their base are opened. Many years ago Hajek made a practice of introducing a short right-angled hook for breaking up the ethmoidal labyrinth. (Figs. 79 and 80.) This hook can be used in two ways:—It can be introduced into the olfactory fissure as far back as the front face of the sphenoidal sinus, and the point of the hook then turned outward so that it lies horizontally. The hook will not reach the os planum if the handle is kept parallel with the septum. When the hook is in position it is drawn forward through the substance of the ethmoidal labyrinth, tearing through the cells as it proceeds. After the initial opening has been made, the stumps of the partitions between the cells are bitten away with the conchotome. In the second method of using the hook the labyrinth is attacked, not from the top, but from the bottom. The point of the hook is turned upward and entered at the posterior inferior part of the labyrinth; then it is pulled forward and downward. This procedure is repeated as often as is necessary. The operator may in this way open the labyrinth cell by cell.

As soon as the field becomes obscured with blood, the operator has to stop, or, if he proceed, he must do so with the greatest caution. Naturally, many sittings are required before the ethmoidal labyrinth is thoroughly cleaned out. In all ethmoidal operating there is danger of breaking into the cranial cavity, either through the cribriform plate or through the roof of the ethmoidal labyrinth. Such an accident is practically sure to be followed by a fatal meningitis. Even to an operator who has fortified himself with a knowledge of operating distances and has trained himself by prolonged work on the cadaver, operating in the ethmoidal region from within the nose is a blind and disquieting work. The bravest operator generally ends by doing too little. The amount accomplished by the timid operator is insignificant. Much that goes under the name of ethmoidal operating is liable to be the merest puttering. It is criminal to undertake work in the ethmoidal region without previous training on the cadaver and a knowledge of operating distances (Fig. 189) in the nose.

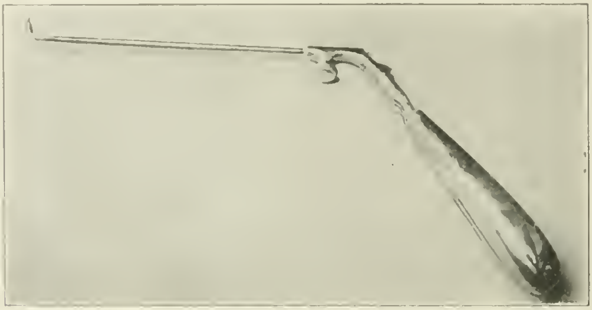


Fig. 79.—Hajek's Hook.

The Anterior or the External Route.—The external route for the removal of the ethmoidal cells is the most satisfactory. It requires an external incision along the outer border of the nasal bone. Many patients object to this. As already stated, however, incisions in the skin of the nose heal very readily and leave surprisingly little scar. As physicians recognize more fully the value of thorough work in the ethmoidal labyrinth for the preservation of good vision, the external operation for ethmoiditis will be urged with greater earnestness upon patients. In very many cases the external operation should not be reserved as the operation of last resort, but should be accepted first. We have the modern radical operation upon the frontal sinus to thank for teaching us the value of the external operation upon the ethmoidal labyrinth. In the external operation, instead of removing the ethmoidal cells one by one, they are all removed at once; instead of working toward the cribriform plate at a dangerous angle, the operator works parallel with it; instead of working in the dark, the operator works with direct illumination given by an electric light reflected into the wound.

Technique.—The middle turbinate should be removed previously under cocaine. The patient is etherized and placed on the operating table in the half-sitting position. The choana and the corresponding nasal cavity are tamponed from the front. An incision is made from the inner end of the eyebrow downward along the outer edge of the nasal bone to its lower limit. This is carried to the bone and the outer half of the nasal bone and the whole of the ascending process of the superior maxilla are stripped of periosteum. The lachrymal sac is turned from its bed and the periosteum elevated from the inner wall of the orbit. The upper part of the ascending process of the superior maxilla is removed with the burr, and the stump of the process levelled with the bottom of the lachrymal groove. The lachrymal bone and the anterior half of the os planum are removed with thin bone-forceps. In this way the anterior end of the ethmoidal labyrinth is exposed. The ethmoidal cells are now removed, if desired, from before backward with a curette, the os planum being used as a guide. Hajek's hook can be used to start the breaking up of the labyrinth. The large size of the opening in the bone makes the use of this instrument very direct and satisfactory. The wound in the skin is sutured and the ethmoidal region is

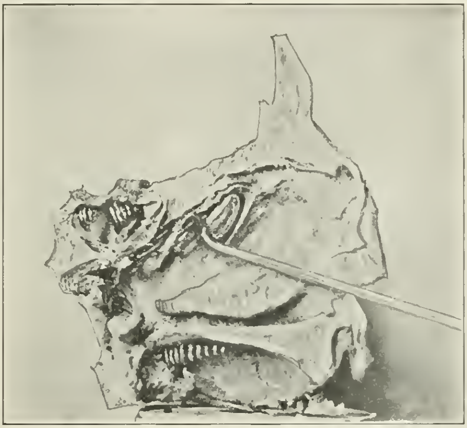


FIG. 80.—This Figure shows the Method of Using Hajek's Hook for Breaking Open the Ethmoidal Bulla. (Original.)

packed through the nose with protected gauze. This is removed in twenty-four hours.

IV. THE APPLIED ANATOMY AND THE DISEASES OF THE FRONTAL SINUS.

Anatomy.—There are two frontal sinuses, a right and a left. They are separated by a median partition which corresponds to the sagittal suture of the skull. (Figs. 81 and 82.) Each sinus is placed in the middle and inferior part of the front of the frontal bone. All recent studies demonstrate that the sinuses correspond to anterior ethmoidal cells which have developed upward from the ethmoidal region and have separated the two plates of the frontal bone. There is always, therefore, an intimate relation between the frontal sinus and the ethmoidal region, since one is but the continuation of the other.

Size.—The development of the sinus begins after birth. At eight years it extends above the root of the nasal bone one quarter of an inch. The adult sinus measures vertically from three-quarters of an inch to an inch, and horizontally from the median line one inch; that is, it reaches the middle of the upper rim of the orbit. The capacity of the adult sinus is about one drachm and a half.

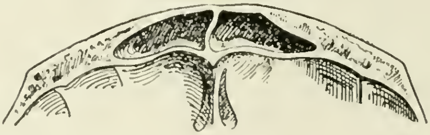


Fig. 81.—Section of Skull Showing Triangular Form of the Frontal Sinuses. (Sieur and Jacob.)

Owing to deviation of the septum between the sinuses the two are seldom of the same size. The prominence of the superciliary ridge is but a poor guide to the size of the sinus.

Vessels.—The veins of the sinus are in relation with the superior longitudinal sinus of the brain, and the lymphatics connect with the subarachnoid space. There is a plentiful supply of nerves which makes the sinus very sensitive.

The Mucous Membrane.—The mucous membrane of the frontal sinus is a continuation of the mucous membrane of the nose, but is not as thick. This difference is due to the fact that the mucous membrane of the sinus has few glands and no cavernous tissue. (Figs. 83 and 84.)

The Form of the Sinus.—There are two varieties of the frontal sinus—the small sinus and the large.

The Small Sinus.—The small frontal sinus is one in which the ethmoidal cell has remained at the top of the ethmoid labyrinth as the highest ethmoid cell, without corresponding separation of the two plates of the frontal bone. Such a sinus is located within the upper inner angle of the orbit. (Fig. 85.)

The Large Sinus.—What may be taken as the normal sinus is one which comes out of the orbit upon the brow. Such a sinus is classed as a large sinus. In the median line the height varies between three-quarters of an inch and an inch. In very large examples the vertical measurement may be two inches. (Fig. 86.)

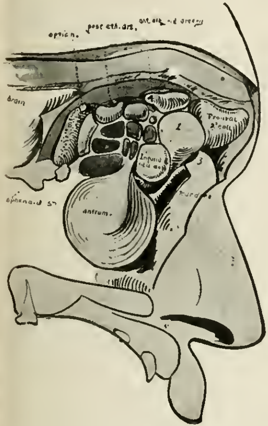


FIG. 82.

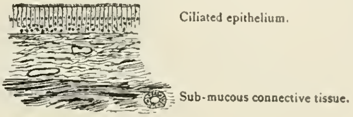


FIG. 83.

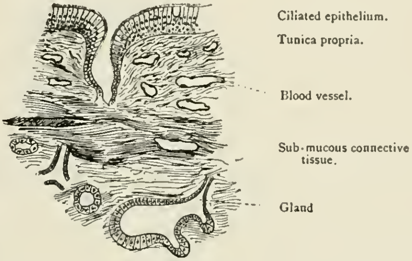


FIG. 84.

FIG. 82.—Drawing from a Formalin Preparation of the Accessory Sinuses and the Ethmoidal Cells. The plate shows how the frontal sinus is nothing but an enlarged anterior ethmoidal cell. In this case the second of the four frontal cells becomes the frontal sinus. (Killian.)

FIG. 83.—The Mucous Membrane of the Frontal Sinus. (Piersol.)

FIG. 84.—The Respiratory Mucous Membrane. (Piersol.)

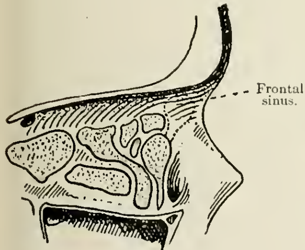


FIG. 85.

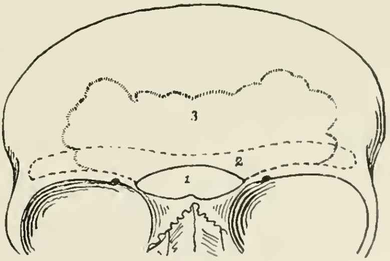


FIG. 86.

FIG. 85.—Frontal Sinus Reduced to the Size of an Anterior Ethmoidal Cell. (Sieur and Jacob.)

FIG. 86.—Diagrammatic Figure Showing Three Varieties (1, 2, 3) of the Large Frontal Sinus. (Hajek.)

The large sinus is often still further enlarged by prolongations—a prolongation outward over the superciliary ridge, and a prolongation backward over the orbit.

The Outward Prolongation.—Usually the sinus extends outward from the median line one inch, that is, to the middle of the orbit. Where there is a large outward prolongation the entire length of the sinus may be as much as two inches—that is, it may extend as far as the malar bone. (Fig. 86.)

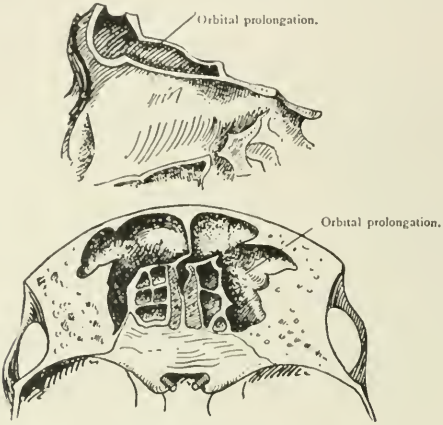


Fig. 87. The Backward or Orbital Prolongation of the Frontal Sinus. (Sieur and Jacob.) In the upper figure the prolongation is shown in a vertical, in the lower one in a horizontal, section.

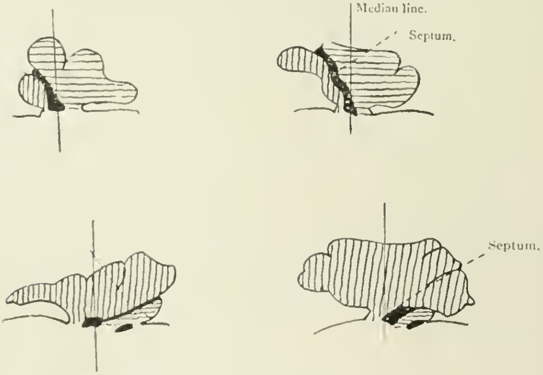


Fig. 88.—Deviation of the Median Septum. (Tilley.)

The Backward Prolongation.—The backward or orbital prolongation runs backward over the orbit on the inner side of the sinus and over the ethmoidal labyrinth, to end blindly from half an inch to an inch from the rim of the orbit. (Fig. 87.)

The Septum of the Sinus.—The septum of the sinus is a thin triangular plate of bone placed vertically, as a partition common to both, between the two sinuses. Very rarely are there perforations in it. I have found but one undoubted perforation in at least five hundred heads. No matter how much the upper part of the septum may deviate, the base is nearly always in the median line. Owing to marked deviation of the upper part of the median partition one sinus may extend far beyond the central line into the territory of the opposite sinus. (Fig. 88.)

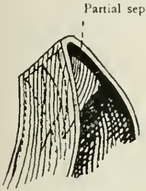


FIG. 89.

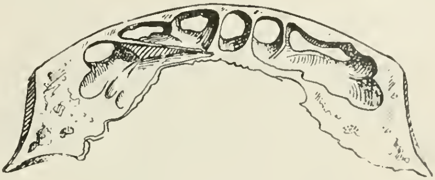


FIG. 90.

FIG. 89.—Diagrammatic Drawing Showing, at the Summit of the Frontal Sinus, Partial Septa Parallel with the Median Septum. (Original.)

FIG. 90.—Partial Septa Making Pockets in the Upper Part of the Frontal Sinus. (Sieur and Jacob.)

Incomplete or Partial Septa.—In addition to the median septum which is complete, the frontal sinus often has septa which are partial or incomplete. These have two seats of predilection—one at the summit of the sinus, and the other in the backward or orbital prolongation. Partial partitions are found in about ten per cent of all sinuses. (Figs. 91 and 92.) In about five per cent of cases there is found a nearly complete partition. It is important to recognize such a partition, as, if present, it will (unless removed) vitiate any operation which is undertaken for the cure of disease of the sinus.

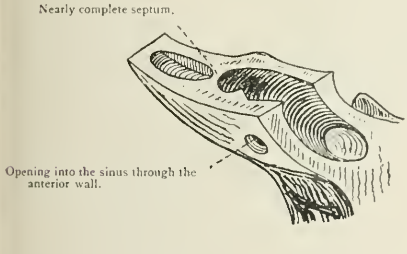


FIG. 91.

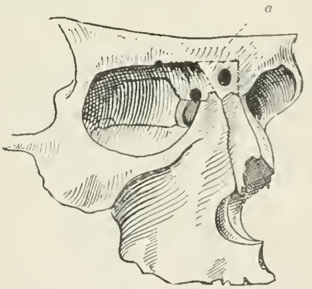


FIG. 92.

FIG. 91.—Large Septum Nearly Dividing the Sinus into Two Parts. An opening made through the anterior wall of the sinus in the position indicated in the drawing would lead the operator to think that this septum was the outer wall of the sinus. (Original.)

FIG. 92.—The Black Circular Area just Above the Lachrymal Bone Shows the Region where the Sinus, however small, Can Always be Opened. (Modified from Sieur and Jacob.) *a*, The black circle above the root of the nasal bone shows the region where the sinus can be opened in two-thirds of the cases.

The Anterior Wall.—Taking bodies as they are encountered in the dissecting-room we shall find that in one-third of them the frontal sinus is of the undeveloped or small variety, that is, it does not come out into the region of the brow, but remains confined within the upper inner angle of the orbit as the highest ethmoidal cell. For surgical purposes such a sinus has no anterior wall. In two-thirds of the cases the sinus extends into the brow throughout a length of from three-fourths of an inch to one inch. Therefore, the only place where one is sure to reach it is within the orbit at its upper inner angle, behind and above the ascending process of the superior maxilla, and the next surest place is at the root of the corresponding nasal bone. (Figs. 92 and 149.)

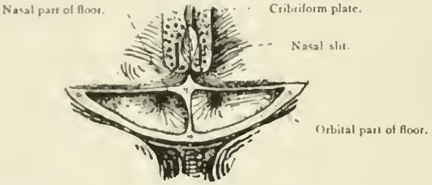


Fig. 93.—The Divisions of the Floor of the Frontal Sinus. (Original.)

The Posterior or the Cranial Wall.—The posterior wall of the sinus forms a part of the front wall of the cranial cavity.

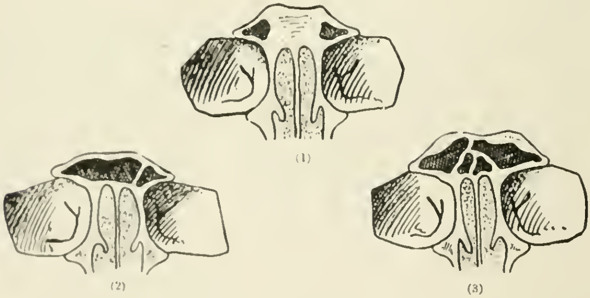
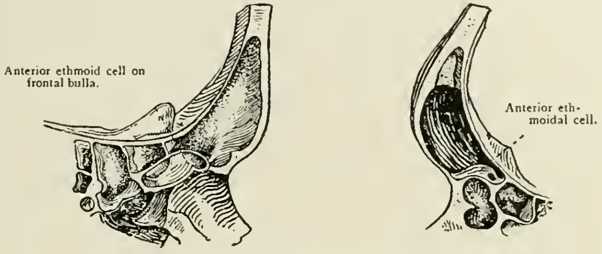


Fig. 94.—The Relationship of the Floor of the Frontal Sinus with the Roof of the Nasal Fossa. (Sieur and Jacob.)

(1) Nasal roof not in relation with the sinus, (2) the right frontal sinus in relation with the nasal fossa of both sides, (3) anterior ethmoidal cells intervening between the floor of the sinus and the roof of the nose.

The Floor of the Frontal Sinus.—The relationship between the floor of the frontal sinus and the roof of the ethmoidal labyrinth is constant. If the sinus is small the relationship with the roof of the orbit and with the roof of the nasal fossa may disappear. (Figs. 93 and 94.)

The relationship between the floor of the frontal sinus and the ethmoidal cells is very important. The anterior ethmoidal cells make the floor of the sinus, and often project like mounds into it. In this way they may obstruct the drainage duct of the sinus. (Figs. 95, 96, and 97.) When an ethmoidal cell projects like a mound into the floor of the sinus it is easy to break through the roof of this and to make a large opening down into the ethmoidal region of the nose. The floor of the frontal sinus is either funnel-shaped or saucer-shaped. (Figs. 99, 100, 101, and 102.)



(1) (2)

Fig. 95.

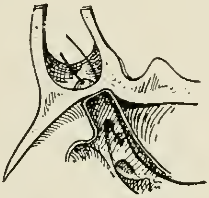
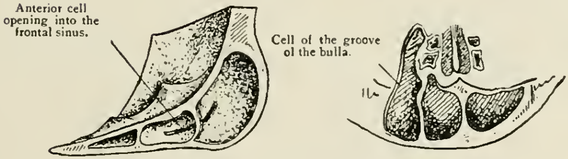


Fig. 96.


Anterior cell opening into the frontal sinus.
Cell of the groove of the bulla.

(1) Fig. 97. (2)

Fig. 95.—Relationship of the Anterior Ethmoidal Cells to the Frontal Sinus. (Sieur and Jacob.) (1) An anterior ethmoidal cell (frontal bulla) projecting into the floor of the frontal sinus; (2) an anterior ethmoidal cell opening into the frontal sinus.

Fig. 96.—An Anterior Ethmoidal Cell Projecting like a Mound into the Floor of the Frontal Sinus. A probe has been pushed through this into the sinus, as shown by the anterior marker. The posterior marker shows the route into the sinus through its ostium. (Sieur and Jacob.)

Fig. 97.—Relationship of an Ethmoidal Cell and of a Cell of the Bulla to the Frontal Sinus. (1) An anterior ethmoidal cell opening into the frontal sinus. (Onodi.) (2) A cell from the groove of the bulla passing to the outside of the frontal sinus and reaching the orbital rim. Such a cell often has been called an accessory frontal sinus. (Original.)

The dangerous area of the sinus is the posterior internal angle of the floor, since here the cribriform plate comes into close relationship. (Figs. 103 and 104.)

All strong curetting of the sinus, therefore, should be done in an outward and downward direction, never backward and inward.

The Naso-Frontal Duct.—The sinus empties into the middle meatus of the nose, to the outside of the anterior end of the middle turbinate, by a canal about half an inch long—the naso-frontal duct. This starts from the posterior part of the floor an eighth to a quarter of an inch from the median septum. When one tries to find it from within the sinus, the tendency is to hug the septum of the sinus. (Figs. 100, 101, and 102.) If the floor of the sinus is funnel-shaped the probe is guided at once into the duct, but if the floor is of the saucer-shape variety the probe must be moved outward away from the septum and also backward before it will enter the duct. It is usually impossible to catheterize the sinus without first gaining room by the removal of the anterior end of the middle turbinate. Not only does the turbinate hinder catheterization, but any enlargement of this structure tends to block the drainage canal. All intranasal work for the purpose of bettering the drainage of the frontal sinus is focussed about the anterior end of the middle turbinate. The frontal sinus is placed directly above the antrum, so that in one-half of the cases a probe can be passed from the frontal sinus into the antrum below. Pus, of course, could find its way more readily than the probe. From its anatomical position, therefore, the antrum is often only a cesspool for the frontal sinus.

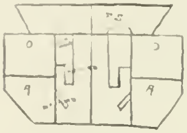


Fig. 98.

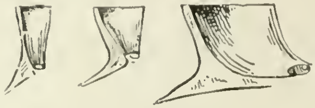
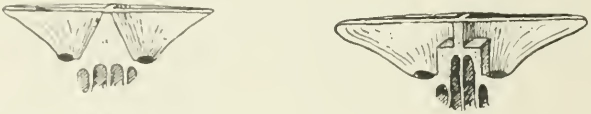


Fig. 99.

Fig. 98.—Diagram to Show the Relationship of the Roof of the Ethmoidal Labyrinth to the Floor of the Frontal Sinus. (Original.)

Fig. 99.—The Forms of the Floor of the Frontal Sinus. (Original.)

The first two figures show the conical floor or the funnel-shaped floor. The last figure shows the saucer-shaped floor. In the funnel-shaped sinus the naso-frontal duct is easy to find. In the saucer-shaped floor the duct is hard to find and must be sought for well backward.



(1) (2)

Fig. 100.—Diagrammatic Transverse Sections of the Floor of the Frontal Sinus. (Original.)

(1) Transverse section of the funnel-shaped sinus. In such a sinus the naso-frontal duct is easily found. (2) Transverse section of a frontal sinus where there is a right-angled ledge or step of bone springing from the median partition. If, in an attempt to pass a probe into the nose from such a sinus, the probe is carried down close to the median septum, it would strike on this ledge and not enter the naso-frontal duct. It is a good rule, therefore, to keep an eighth or a quarter of an inch away from the median partition in order to avoid this step. When the duct is not readily found, move the probe, not only outward but also in a backward direction.

THE PULLEY OF THE SUPERIOR OBLIQUE MUSCLE.—The superior oblique muscle is attached just within the upper, inner angle of the orbit to the inside of the supra-orbital notch. (Figs. 107 and 108.) In all operations on the sinus within the orbit this muscle lies in wait for the operator. If it is disturbed it gives temporary double vision, and occasionally the trouble is permanent.

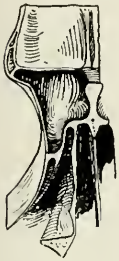


FIG. 101.

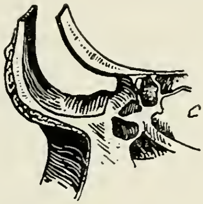


FIG. 102.

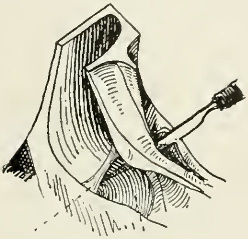


FIG. 103.

FIG. 101.—Frontal Sinus with Rectangular Ledge Projecting from the Median Septum. If the probe hugs the median septum when the attempt is made to find the naso-frontal duct, it strikes upon this ledge. (Original.)

FIG. 102.—Saucer-shaped Sinus. (Original.)

FIG. 103.—Prolongation of the Ethmoidal Plate Forward in a Finger-like Process. The point of the knife is inserted into this and is seen through the outer wall of the prolongation. This prolongation is in the posterior internal angle of the floor of the sinus, and makes the inner wall of the naso-frontal duct. (Original.)

The muscle is attached to the periosteum of the orbit. If it is necessary to get it out of the way, one may elevate the periosteum which supports it without producing lasting inconvenience, but the pulley of the muscle will not tolerate rough dissection.

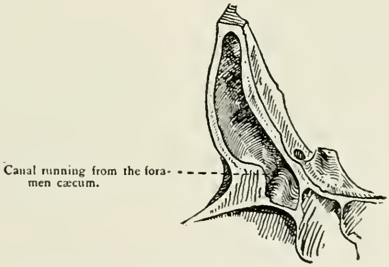


FIG. 104.—A Marked Canal for the Vein of the Foramen Cæcum. This canal projects like a mound into the postero-internal angle of the sinus. (Original.)

Diseases of the Frontal Sinus.—ACUTE INFLAMMATION.—Acute inflammation of the frontal sinus is very common after a cold or after the coryza of influenza. The conditions in the sinus are probably the same as they are in the nose, namely: congestion and œdema of the mucous membrane, combined with an exudation of serum. The duct of the sinus is partially or entirely blocked. These conditions last for a few days or a week. Complete resolution generally follows without the formation of pus.

Symptoms.—The only symptom noticed may be a feeling of weight over the brow. Usually, however, there are neuralgic pain and tenderness over the lower part of the brow and tenderness within the upper, inner angle of the orbit. Occasionally ptosis occurs.

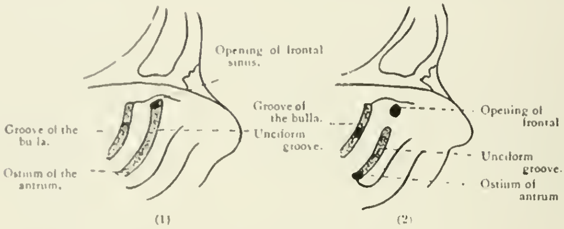


Fig. 105.—Diagrams Illustrating the Relations of the Unciform Groove and the Frontal Sinus. (Hajek.)

(1) Frontal sinus opening into the unciform groove. This happens in twenty-five per cent of cases. (2) The unciform groove ends blindly. The frontal sinus opens just above the unciform groove and in line with it. This happens in about fifty per cent of cases.

Diagnosis.—Acute inflammation of the frontal sinus is often confounded with supra-orbital neuralgia. At times the two conditions cannot be separated with certainty. In neuralgia the pain extends farther along the course of the nerve, upon the scalp, and there is a history of neuralgia in other parts of the body. Before a positive diagnosis is made it will be necessary to rule out the pain and tenderness, as well as the supra-orbital neuralgia, caused by the perios-

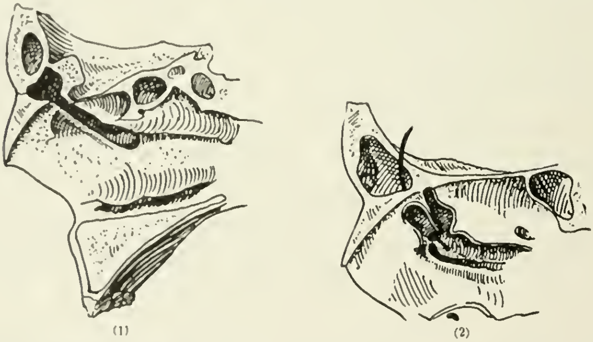


Fig. 106.—Relations of Unciform Groove and Frontal Sinus Continued. (Sicur and Jacob.)

(1) Frontal sinus opening directly into the unciform groove. No naso-frontal canal. (2) Marked naso-frontal canal.

titis of syphilis. The nasal examination shows only the ordinary findings of an acute coryza.

Treatment.—The frontal sinus must be drained. This is best done by cleaning the nose with a warm alkaline spray or douche and then using every three hours a weak spray of adrenalin oil (1:15,000). The effect of this drug must be watched, because many patients do not tolerate it. If the drug is not well borne, camphor and menthol can be employed in its place. It is useful to pack the middle meatus with cotton moistened with menthol and cocaine for some minutes and then to attempt to blow warm air into the sinus. If this attempt succeeds it gives great relief. Work in the middle meatus and the application of cocaine are, of course, office procedures. The patient should be caused to perspire. Cold or heat is used over the brow, and phenacetin, sodium or potassium bromide, or morphia is given according to the severity and the persistency of the pain. Unless this line of treatment lessens the symptoms markedly within the first three days, the anterior end of the middle turbinate should be removed. The theory of this procedure is that it allows the sinus to drain and depletes the congested blood-vessels of the mucous membrane. It is only rarely that pus flows from the sinus after this is done; but, whether this happens or not, the clinical fact remains that the procedure quickly brings improvement.

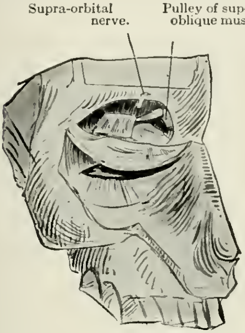


FIG. 107.

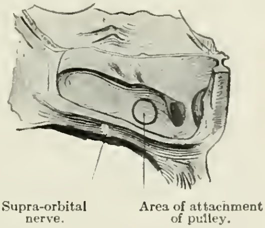


FIG. 108.

FIG. 107.—Drawing from a Wet Specimen, Showing the Pulley of the Superior Oblique Muscle. (Original.)

FIG. 108.—The Area of the Attachment of the Pulley of the Superior Oblique to the Under Surface of the Frontal Sinus. (Original.)

CHRONIC INFLAMMATION OF THE FRONTAL SINUS.—Acute inflammation of the frontal sinus often is a trivial complaint. Chronic inflammation never is trivial.

Etiology.—But little is known of the etiology of chronic inflammation—or, as it is usually called, chronic suppuration—of the frontal sinus. Two distinct groups of cases, however, can be recognized: cases due to chronic retention, and cases due to chronic infection. In the first group the contents of the sinus consist of mucus and are sterile; in the second, they consist of pus, and any of the well-known bacteria may be present—as, for example, the bacillus of influenza, the pneumococcus, the streptococcus, and the less virulent organisms, such as the staphylococcus pyogenes aureus and albus.

The cases of the first group are due to the retention of mucus in the sinus, owing to the stoppage of its duct. Combined with the stoppage of the duct of the sinus, there may be a mucoid degeneration of the glands. When this occurs there is marked destruction of bone from pressure. These cases, furthermore, are often complicated by hemorrhages from the vessels of the mucous membrane, as a result of which the sinus is found at operation to be filled either with a brown bloody fluid or with a brown jelly-like mass which the microscope shows to be chiefly blood.

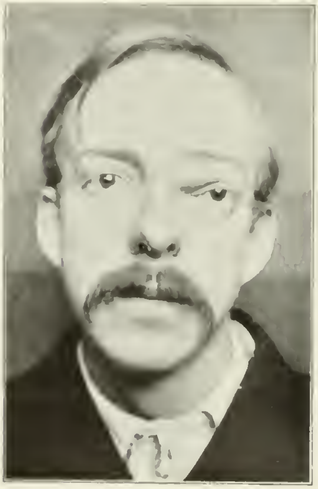


Fig. 109.—Empyema of the Left Frontal Sinus, which has Broken through the Roof of the Orbit and Caused Exophthalmos. At operation it was found that the floor of the sinus and the anterior half of the os planum had disappeared through necrosis. (Original.)

The cases of the second group are cases of chronic suppuration; the infecting organism entering the sinus from the nose.

Among the other causes of chronic suppuration is syphilis. It is probable that, in the future, tuberculosis also will be found to play its part. In suppurative cases destruction of bone is not so common nor so extensive as in the cases due to retention. In the latter cases the bone destruction is due to pressure necrosis. Trauma can start chronic suppuration in the frontal sinus. A sequestrum is generally due to trauma. Recent investigation has shown that the periosteum is rarely involved except in cases of syphilis. In cases of chronic retention or in cases of mucocele the mucous membrane is gradually destroyed; in suppurative cases the mucous membrane becomes thickened and polypoid.

Symptoms.—The chief symptoms of chronic disease of the frontal sinus are interference with vision, ethmoidal tumor, exophthalmos, purulent discharge from the nose, and chronic frontal headache. There is tenderness over the lower part of the brow and especially in the upper, inner angle of the orbit. There may also be gastric symptoms and dizziness.

Cases of chronic suppuration in the frontal sinus can be divided again into two groups:—

1. Cases in which the chief features are the eye symptoms.
2. Cases in which the chief features are pain and nasal discharge.

a. The first group: The characteristic features in cases of the first group are disturbance of vision and ethmoidal tumor or exophthalmos. Ethmoidal tumor is seen as a rounded swelling above the inner canthus of the eye and is due to pus breaking into the orbit through the lachrymal bone. Exophthalmos, on the other hand, is due to pus breaking into the orbit through the floor of the frontal sinus and pushing the globe of the eye downward and outward. (Figs. 109 and 110.) In one-half of the cases of the first group there is no pus in the nose. Pain is not a prominent symptom; in fact, most of these cases are painless. Formerly, cases of this nature were classed as cases of orbital abscess. They are, indeed, cases of orbital abscess, but of a secondary character. The cases of this first group are due to chronic retention—that is, they are primarily mucoceles.

b. The second group: The majority of the cases of the second group present neither ethmoidal tumor nor exophthalmos. Instead, these cases have pus and polypi in the nose. There is very marked pain.

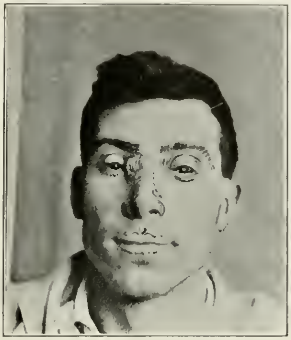


FIG. 110.—Abscess in the Region of the Lachrymal Sac, Simulating Ethmoidal Tumor. Examination by x-ray was negative, and the nasal examination was negative. The abscess was evacuated and cured by an external incision. (Original.)

As a rule, patients of the first group come first to the eye clinic, while patients of the second group come first to the throat clinic.

Diagnosis.—In cases where there is ethmoidal tumor or exophthalmos, unless the x-ray locates the disease in the frontal sinus, only an exploratory operation will rule out the various new-growths of the orbit or affections of the tear sac. In the majority of cases, if there is fluid or pus in the frontal sinus, the x-ray plate will show its presence. It should be remembered that chronic suppuration in the antrum will cause pain over the brow, and that the pain caused by chronic suppuration in the frontal sinus is sometimes referred to the occipital as well as to the frontal region. Further, it should be borne in mind that pus in the middle meatus may come from the ethmoidal region or from the antrum as well as from the frontal sinus. Where there is pain over the eyebrow, combined with tenderness in the same locality as well as in the upper angle of the orbit, with œdema of the brow and the upper lid, and with pus in the nose, the diagnosis of chronic suppuration in the frontal sinus is practically certain. It can be made positive only by entering the sinus through the middle meatus and by withdrawing pus through a catheter or along a probe.

Therapeutic Procedures in Connection with the Frontal Sinus.—CATHETER-

IZATION.—It is not usually possible to catheterize the frontal sinus without first removing the anterior end of the middle turbinate. (Fig. 111.) The sinus is catheterized in the following manner:—A catheter is bent at an angle of about ninety degrees. If, when bent in this manner, the instrument cannot be successfully introduced, the angle is made a little more or a little less than ninety degrees. The catheter is passed to the roof of the anterior part of the middle meatus and an attempt is made to find the unciform groove on the outer wall of the middle meatus and to follow this upward as a guide. As a rule, the groove cannot be distinguished, and consequently the catheter is at once pushed to the roof of the meatus and its point turned upward, then outward, then forward, and finally backward, until the opening of the frontal duct is discovered. If a drop of pus is seen at the top of the middle meatus, this often will indicate the position of the duct. The distance of the lower end of the frontal duct from the posterior edge of the alar cartilage of the nose is two inches. When the catheter is in the sinus its shaft should lie snugly against the upper lip. A small-sized Eustachian catheter will usually enter the duct. Occasionally, however, a small silver cannula, not more than 1.5 mm. in diameter, must be used. Where the catheter enters the sinus by a large opening it is probable that it has broken its way through the roof of an ethmoidal cell which projects like a mound into the floor of the sinus. Such cells are as thin as paper, and are easily broken by a catheter or by the necrosing action of pus.

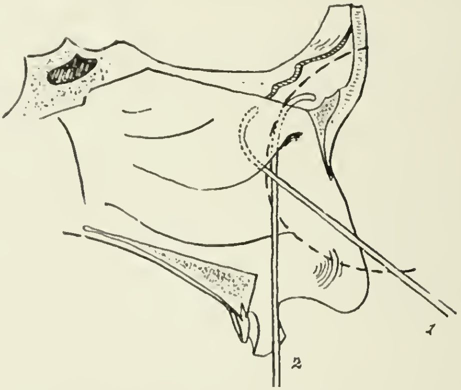


FIG. 111.—The Method of Catheterizing the Frontal Sinus. (Modified from Sieur and Jacob.) (1) First position. (2) Final position. The dotted half-circle gives the curve which a probe must have in order to come out of the anterior nares when passed down from the sinus, through the naso-frontal duct into the nasal cavity.

GENERAL CONSIDERATIONS.—The patient can be operated upon in the recumbent, the half-sitting, or the sitting position. The half-sitting position is best. (Fig. 112.) Before the anaesthetic is administered the patient is given subcutaneously one one-hundredth of a grain of atropine and a sixth of a grain of morphine. The atropine controls the secretion of the pharynx and of the bronchi, and the morphine makes the etherizing progress more steadily and easily. When the patient is ready to be placed on the operating table the ether cone is replaced by the ether-vapor machine, which is set in action by means of a foot bellows or by the Junker apparatus, which is worked by a hand bulb. Chloroform gives a quieter narcosis than ether. The mouth is kept open by a self-retaining gag, and the tongue is controlled by a long suture passed through it near the tip. In order to obtain a view of the recesses of the frontal sinus or of the ethmoidal region it is necessary to illuminate the operating field with light reflected from a head mirror, to use small electric lights which can be sterilized and placed in the wound, or to employ a forehead lamp. Kirstein's head lamp is the best for this purpose. The objectionable feature of the instrument is that it becomes hot and is tiresome for the eye. It is well, therefore, to use it in alternation with the small electric lamp that is armed with a lens tip. Some operators use this exclusively. Before the operation is begun, all

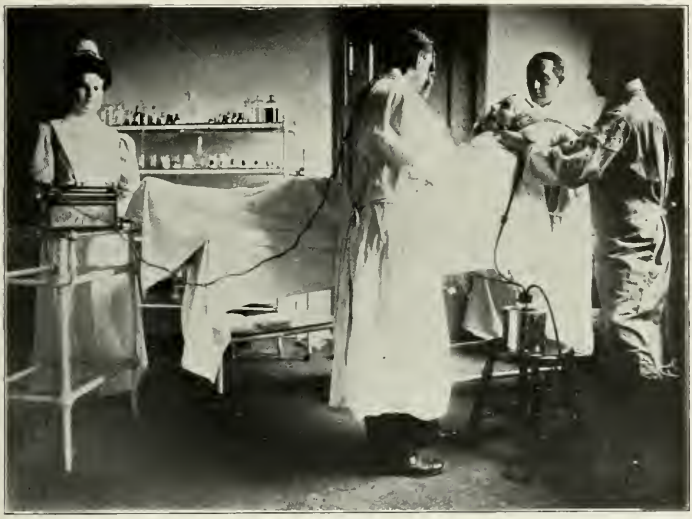


FIG. 112.—Positions of Patient, Operator, Assistants, and Etherizer for Operation on the Left Antrum, the Left Ethmoidal Region, and the Frontal Sinus. (Original.)

The first assistant is opposite the operator, the second assistant holds the patient's head, and the nurse runs the table with the sponges.—The etherization is carried on by the ether-vapor machine. The foot bellows from which the power is supplied is in shadow in the photograph. The ether bottle is set in a receiver containing warm water, so that concentrated and warm ether vapor is forced through the mouthpiece into the pharynx of the patient. This apparatus is made by the Davidson Rubber Company, Boston. If the surgeon prefers chloroform or chloroform and ether, the Junker apparatus, which is simpler than the ether-vapor machine, can be used equally well.

lights should be tested and extra lamps should be on hand. One assistant should be taught how to run the lamps and how to replace them.

The windows of the operating-room should have thick, dark shades, so that one may easily darken the room. In order that the surgeon may operate comfortably there should be at least two assistants besides the anæsthetist.

In all sinus operations the bleeding is so free that the operating field is clear for only a few seconds. Rapid sponging at brief intervals is therefore necessary if one is to be able to see this field. In the depths of the sinus the operator must do his own sponging. For this, he should have close at hand a large supply of conical sponges about an inch long. In the frontal sinus, for instance, if he leaves the first sponge in place for a few seconds and then applies in quick succession a second and a third sponge, he may be able to secure a clear field for a certain length of time. As the operation proceeds, the bleeding becomes less troublesome. Adrenalin chloride seems to help but little.

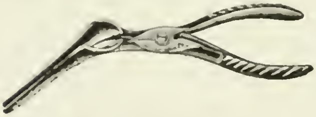


Fig. 113.—Long Nasal Speculum for Examining the Front Wall of the Sphenoid and for Packing the Nasal Cavity and the Choana from the Front. (Killian.)

In a prolonged sinus operation the patient's tongue becomes excessively dry. This can be prevented if the anæsthetist moistens the tongue from time to time with the ordinary glycerin-and-lemon-juice mouth wash. With the concentrated ether vapor given by the ether-vapor machine it is easy to overetherize the patient. This, of course, should be guarded against. In operations upon the sinus expert etherizing is essential.

Plugging the Nose. (Figs. 113, 114, 115, and 116.)—With the patient in the sitting position the frontal sinus and even the anterior ethmoidal cells can be operated upon without plugging the posterior nares. In such cases the blood is kept from the pharynx by the head being brought forward at intervals. When, however, operative work is done upon the posterior ethmoidal cells or upon the sphenoidal sinus, or when the frontal sinus is operated upon with the patient in the recumbent position or in a sitting position, the blood must be kept from the pharynx by plugging the choana of the nose either from behind or from the front. The plug introduced from behind is supposed to endanger the ear through the Eustachian tube. In practice, however, such accidents are rare when the plugging of the posterior nares is for only a short time. Plugging the choana through the nose is a very serviceable method. It not only closes the choana, but obliterates at the same time the cavity of the nose as far as the middle turbinate. In this way the pool of blood in which the operator is obliged to work is reduced in depth one-half. In addition, the pressure of the tampons controls much of the bleeding from the mucous membrane and the ethmoidal cells. In most cases the use of anterior plugging enables the operator to see clearly in the depths of the ethmoidal region. We are indebted, for a knowledge of its advantages, to Killian. The details of the method are as follows:—Five cotton tampons are made of the same length and size as the second finger. Round the middle of each a piece of silk is tied. This is long enough to project two inches beyond the tampon. The turbinates are shrunk with adrenalin, and additional space is gained by forcing the inferior turbinate strongly outward by means of a long thin-bladed Killian speculum. A tampon is then grasped by a pair of stout, flat nasal forceps and introduced in the inferior meatus along the floor of the nose until the end of the tampon projects through the choana. The other end of the tampon and the string attached to it are left projecting from the nose. The body of the tampon fills the bottom of the inferior meatus. A second tampon is introduced along the top of the first one and packed firmly down into place. A third and a fourth are put in, until finally the choana, the inferior meatus, and the lower part of the middle meatus are obliterated. A final tampon, which has to be a little smaller than the others, is forced upward under the bridge of the nose to the front of the middle turbinate. This last tampon controls the blood supply of the mucous membrane of the nose anteriorly. It is therefore important to adjust it carefully. With the patient in the half-sitting position this form of packing protects the pharynx perfectly.

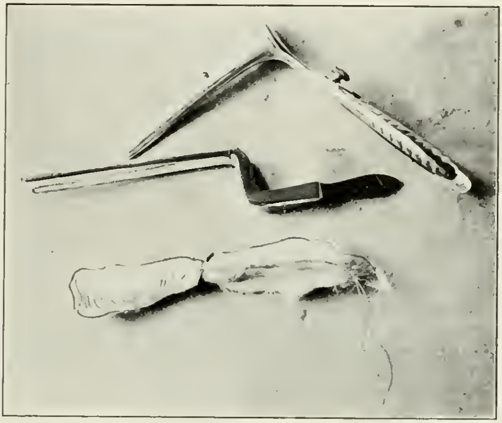


Fig. 114.—Instruments and Cotton Plug Required for Plugging the Choana from the Front. Taken in the order from above downward they are: a Killian long-bladed speculum, a stout bayonet-shaped nasal forceps, and a cotton plug the size of the forefinger, with silk ligature attached to the middle of it.

Irrigation and the Use of Antiseptic Solutions in the Treatment of Chronic Suppuration of the Frontal Sinus.—The cavity of the sinus can be more or less thoroughly washed out with antiseptic or astringent solutions carried to the sinus through a catheter which has been introduced from the nasal cavity. This method is tedious in the extreme, and it rarely cures the suppuration.

Enlarging the Duct of the Sinus from the Nose.—A probe is passed into the sinus. A pierced burr with a flexible shaft is slipped over the probe and then pushed up into the sinus with the probe acting as a pilot. If there is a large basal relationship between the floor of the sinus and the ethmoidal labyrinth the burr can be used without a pilot. By these methods the duct of the sinus may be enlarged and better drainage afforded. In every attempt to enlarge the drainage opening from the sinus into the nose the following difficulty is encountered:—Granulations immediately spring from the raw surfaces of the enlarged opening and soon narrow it to its original calibre or entirely close it. Rubber or metal tubes will keep the new opening patent while they are in place, but they act as foreign bodies and keep up the discharge, and, when they are removed, leave behind a legacy of granulations. A large opening can be made into certain sinuses by these methods, but no matter how large the opening is, intranasal manipulations are powerless to remove polypi, diseased mucous membrane and septa. On this account the cure of chronic suppuration of the frontal sinus by intranasal methods is tedious and uncertain. It is not justifiable to attempt the use of burrs without the aid of a good x-ray plate to

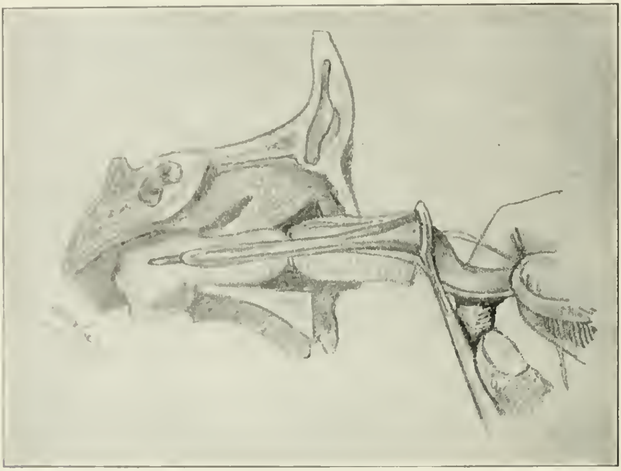


Fig. 115.—Plugging the Left Choana from the Front. (Original.) Vertical median section; the septum has been removed. The drawing shows the manner of introducing the first cotton plug along the floor of the nose through the choana into the post-nasal space. Room is made for the plug by pressing the inferior turbinate outward with the long Killian speculum. The plug is carried in by a stout pair of bayonet nasal forceps. (See Fig. 114.)

indicate just what the possibilities of making a sufficient opening are and in order to minimize the dangers of a blind procedure.

Treatment of Chronic Suppuration of the Frontal Sinus by Way of an Opening Established in the Anterior Wall of the Cavity.—The method of treating suppuration of the frontal sinus through an opening in the anterior wall is applicable only to sinuses which have an anterior wall that can be dealt with surgically. It should be remembered that, in one-third of the subjects encountered on the dissecting table, the frontal sinus does not come forward into the region of the brow, but remains in the orbit as the highest anterior ethmoidal cell. In two-thirds of the subjects, however, the sinus occupies the brow for a distance of from three-fourths of an inch to an inch from the root of the corresponding nasal bone. Therefore the x-ray should first be employed, in order to determine where the sinus is located. If the plate shows that the sinus comes well into the brow, it is allowable to enter the sinus through the anterior wall. Preliminary to the operation the patient's brow is given the usual surgical preparation, with the exception that the eyebrow is not shaved. It has been found that, in those cases in which the eyebrow is shaved, the hairs

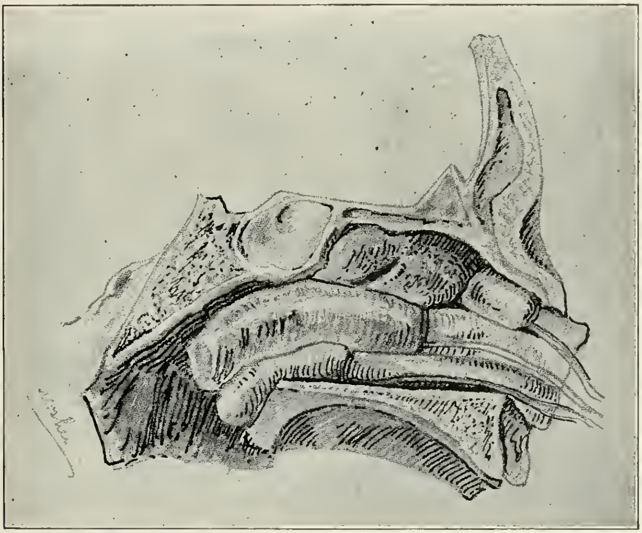


Fig. 116.—Plugging the Left Choana from the Front. (Original.) Vertical median section; the septum has been removed. The figure shows the left choana plugged by two tampons. These not only plug the choana, but obliterate the nasal cavity well up into the middle meatus. A third and smaller tampon obliterates the nasal cavity in front of the middle turbinate. The bleeding from the ethmoidal region is made much less if the tampon in front of the middle turbinate is fitted accurately and tightly.

may not grow out again for a long time, or there may be an overgrowth of the hairs when they do grow out. The steps of the operation are as follows:—An incision is made in the centre of the eyebrow throughout its entire length, and is carried down to the bone. The supraorbital nerve and artery are cut. The artery is tied, if necessary, after a hæmostat has been left on it for a few minutes. Cutting the nerve causes anæsthesia of the brow and of one-half of the scalp anteriorly for a period of from six weeks to two or three months. This occurrence proves decidedly annoying to some patients. The skin and the subjacent muscular tissues and the periosteum are retracted upward as the periosteum is scraped from the bone. A retractor is placed in the inner half of the incision, and the tissues are drawn upward and toward the median line. If the sinus has a large front wall it is hard to retract the skin and subcutaneous tissues sufficiently unless the incision is made through the whole length of the eyebrow. If the incision in the eyebrow is sufficiently extensive it is rarely necessary to supplement it by another incision running at an angle from its inner end. When the front wall of the sinus is freely exposed a small chisel is placed at least a quarter of an inch above the rim of the orbit and a little to one side of the median line, and an opening is made into the sinus. As the operator should be sure of the size of the sinus, from the *x*-ray plate, a burr may be used if he prefers this instrument. The farther above the root of the nasal bone, or above the rim of the orbit, the sinus is entered, the less the resulting deformity. As soon as the sinus is opened its exact size is determined with the probe. The initial opening into the sinus is then enlarged sufficiently to introduce the De Vilbiss bone-cutting forceps, and a linear incision, which runs parallel with the rim of the orbit and keeps at least a quarter of an inch above it, is made in the bone as far as the outer limit of the sinus. This done, enough of the front wall of the sinus is removed with chisel or rongeur to enable the operator to remove all the diseased mucous membrane and polypi and all the septa. In a small sinsu this means that all the front wall will have to be removed; in a large sinus, however, it is often sufficient to remove not more than half of it. When the mucous membrane, polypi, and septa have all been removed from the sinus, a probe is passed from the cavity into the nose. If the floor of the sinus is funnel-shaped the probe readily enters the duct; but if the floor is flat or saucer-shaped, the operator is often obliged to search for some time before he finds the opening. The duct leaves the floor of the sinus at its posterior internal angle, about an eighth of an inch from the middle septum. It is a common mistake to expect to find the opening of the duct close to the middle line. If there is difficulty in finding this opening, the probe should be moved outward and backward. In order to make the probe clear the floor of the nose and present itself at the vestibule, it is necessary to bend it in such a manner that it makes an arc of a circle the diameter of which is two inches. When the probe appears at the vestibule the eye of the probe is threaded with a small piece of selvage tape, and the tape is drawn from the sinus through its duct into the nose and out of the vestibule. The tape, held firmly by its two ends, is sawed up and down until all the mucous membrane is removed from the duct and until the ethmoidal cells which surround the duct are broken up to as great an extent as is possible. Force is always applied downward and forward, never backward and inward. The reason for this is because the wall of the duct often has a prolongation of the cribriform plate lying to its inner side. The duct is further opened and enlarged by passing a bent curette from the sinus into the nose, and also by working upward from the nose into the sinus. In this way it is possible to break up the anterior ethmoidal cells which surround and practically make the walls of the naso-frontal duct. Where the ethmoidal labyrinth is wide and there is a broad basal relationship between it and the floor of the sinus, a large opening can be made from the sinus into the nose. One is tempted to pass a rubber tube from the sinus into the nose and to allow it to remain in the enlarged naso-frontal duct for some weeks. Experience has shown, however, that this gives poor results. A tube or packing should not be left in the duct for more than a few days. If the frontal sinus is closed without packing, it soon fills with blood. This clots and does not drain into the nose, and often it becomes infected. In order to avoid this it is well to pack the sinus for from twenty-four to forty-eight hours and then to remove the gauze and to tie the provisional skin sutures which are left for this purpose.

The Method of Obliterating the Frontal Sinus through the Formation of Granulation Tissue.—Of late years the method of treating chronic suppuration of the frontal sinus by obliterating the cavity of the sinus by granulations and connective tissue has been much used; it has proved a fairly successful mode of treatment. In theory it is simple, but it requires great care and thoroughness in order to make it produce the result desired.

The operation is done in the following manner:—An incision is made the full length of the eyebrow and carried down to the bone. The skin, the subcutaneous tissues, and the periosteum are retracted upward until the front face of the sinus is well exposed. An opening is then made into the sinus near the middle line, and the size of the sinus confirmed with the probe. Next, a sufficient amount of the front wall of the sinus is removed to enable the operator to see every part of the cavity, to break down all septa, and to remove thoroughly all of the mucous membrane. On this point the greatest care has to be taken. If a bit of diseased mucous membrane is left, it will infect the granulations and prolong the healing or necessitate a second operation. A piece of gauze is passed through the duct of the sinus and brought out of the nose, and then drawn up and down until the mucous membrane is entirely removed from the duct. If the anterior ethmoidal cells are diseased, they must be broken down partly by working downward from the sinus and partly by working upward into the sinus from the nose. A bent curette is used for this purpose. For working in the pockets and the recesses of the frontal sinus Coakley has devised a set of bent curettes which are of the greatest service.

After the crucial point in the operation—namely, the thorough removal of septa and diseased mucous membrane—has been accomplished, the sinus is packed with gauze. The aim of the operation is to obliterate the cavity of the sinus. The packing should be so carried out that the granulations obliterate first the naso-frontal duct. This accomplished, the packing is gradually withdrawn, allowing the sinus to fill with granulation tissue from the bottom. The resemblance to the healing of the wound cavity after the usual mastoid operation is apparent. When the operation upon the sinus is completed, the incision in the eyebrow is closed except at the point which is the most favorable for inserting the packing. The packing is renewed every second or third day until the granulations and the resulting connective tissue entirely fill the sinus. The time required for attaining this result depends, of course, upon the size of the sinus, and varies from six weeks to as many months. In the case of a small sinus there is no depression of the scar; in the case of a large one, on the other hand, the scar sinks in markedly. This depression can be remedied by injecting paraffin. Paraffin, however, must be injected into sterile connective tissue, as otherwise it will act as a foreign body. Usually paraffin is injected in a semi-solid state with a

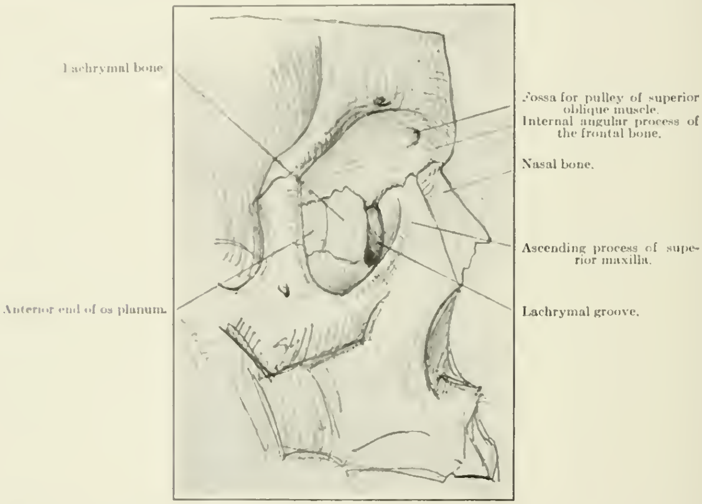

Lachrymal bone
Fossa for pulley of superior oblique muscle.
Internal angular process of the frontal bone.
Nasal bone.
Ascending process of superior maxilla.
Lachrymal groove.
Anterior end of os planum.

FIG. 117.—Drawing to Show the Normal Anatomy of the Anterior Half of the Inner Wall of the Right Orbit. (Original.)

syringe, but it can be put in as a solid cast if the sunken scar is first dissected from its bed and then sutured back in place after the paraffin has been introduced.

The bone incision and the incision in the skin should be so located that the one lies directly under the other. Otherwise it is very hard to pack the sinus satisfactorily. It is essential that the cavity of the sinus close steadily from the bottom without forming pockets. If pockets form, the pain promptly returns and there is danger that the enclosed pus will infect the tissue that has already formed and necessitate a cleaning out of the sinus.

This operation is best suited to sinuses which do not have deep prolongations, especially deep orbital prolongations. A successful granulating operation leaves the very satisfactory feeling that the sinus is obliterated and out of the way. Coakley is the sponsor of this operation in America and has done more operations by this method than any other surgeon. In my hands the operation has proved tedious and the packing somewhat painful.

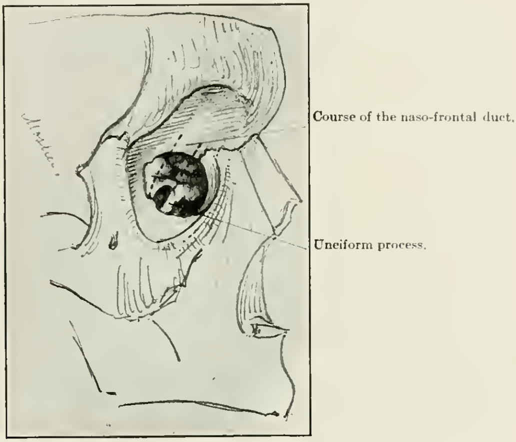


Fig. 118.—Ethmoidal Labyrinth, as Seen from the Cavity of the Orbit. (Original.) The lachrymal bone has been removed, thus exposing the outer surface of the anterior end of the ethmoidal labyrinth. The dotted lines show the course of the naso-frontal duct as it passes down through the ethmoidal labyrinth. If this part of the labyrinth is broken down, the naso-frontal duct is destroyed and its place is taken by a roomy chamber. The destruction of the anterior ethmoidal cells and the consequent enlargement of the naso-frontal duct are among the main objects to be accomplished in the radical operation on the frontal sinus.

The Killian Operation.—The Killian operation is the second operation which has for its purpose the obliteration of the sinus. This operation is one of the most satisfactory that we have for the cure of chronic suppuration in the frontal sinus. It is best suited to sinuses that are of good size and that are distinctly located in the brow. The obliteration of the sinus is accomplished by removing the greater part of the anterior wall and by taking away the whole floor. The removal of the anterior bony wall permits the skin of the forehead to fall back against the posterior wall, and the removal of the floor of the sinus permits the orbital fat to rise into that part of the cavity which is not occupied by the flap of skin. As a further step in the operation the anterior ethmoidal cells are removed. Between the two openings—one in the anterior wall and the other in the roof of the orbit—there is left, at the inner angle of the orbit, a bridge of bone. This aids in minimizing the subsequent deformity. In a small sinus the deformity after this operation is slight; in a large sinus it is marked. All things considered, however, the deformity is insignificant in comparison with the benefits resulting from the cure of such a troublesome condition as chronic suppuration in the frontal sinus and the ethmoidal cells. (Figs. 117, 118, and 119.)

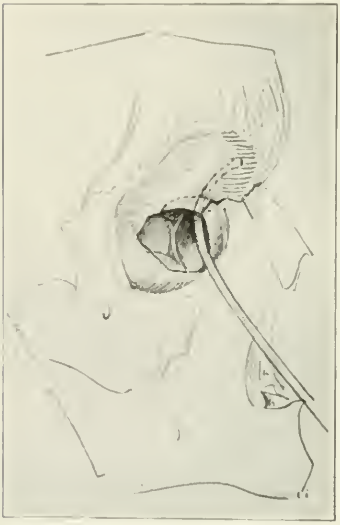


FIG. 119.—Diagrammatic Drawing, to Show the Surest Method of Finding the Frontal Sinus. (Original.) The lachrymal bone has been removed and a probe passed upward and forward into the frontal sinus, the posterior edge of the ascending process of the superior maxilla being used as a guide. This is the surest way of finding a small frontal sinus.

Detailed Description of the Operation.—The patient is placed in the half-sitting position at an angle of forty-five degrees. It is better to remove the middle turbinate under cocaine at a previous sitting. When this course is not adopted, the middle turbinate should be removed with scissors or with a ring punch as the first step in the ether operation. After this the choana is tamponed from the front, and the cavity of the nose obliterated with packing which is pushed well into the middle meatus. (See Figs. 115 and 116.) The first assistant places the fingers of his right hand flat on the patient's forehead and renders the eyebrow tense by pulling upward. (Fig. 120.) At the same time, by backward pressure, he controls the supra-orbital artery. The operator places the ball of his left thumb under the rim of the orbit and presses upward. In this way the eyebrow is steadied both from above and from below, and at the same time the vessels about it are compressed. An incision is made through the whole length of the centre of the unshaven eyebrow. (Fig. 121.) At the inner end the incision is curved downward and carried along the outer border of the nasal bone to its lower edge. In order to bring the edges of the incision together accurately at the end of the operation, small cross-cuts are made at intervals of half an inch to serve as guides. In the eyebrow and along the nasal bone the incision is carried down to the bone, but just above the nasal bone, over the internal angular process of the frontal bone, the periosteum is not cut through, because at this point the bridge is to be made. As the incision is being made along the nasal bone the operator presses firmly with the first two fingers of his left hand on one side of it while his assistant makes pressure on the other side and advances as he advances. The bleeding at the inner angle of the orbit is often free enough to be annoying. Vessels from which the bleeding is not readily controlled by pressure are snapped by hæmostatic forceps, which are left hanging. At a later stage of the operation, when these are removed, it is not usually necessary to tie any vessels.

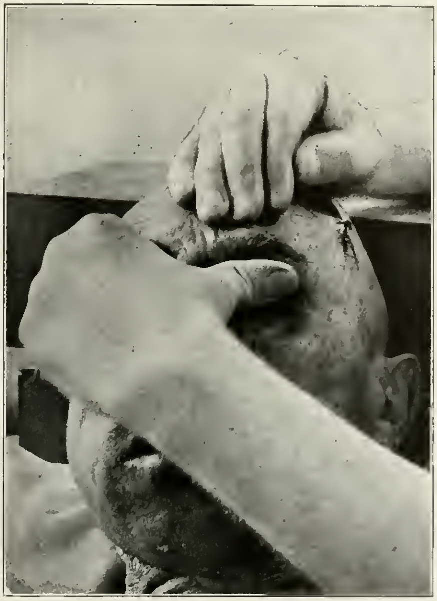


Fig. 120.—First Steps in the Killian Operation. (Original.) The assistant is retracting the skin of the forehead slightly upward, while at the same time he is pushing backward and controlling the supra-orbital artery. The lower hand is the hand of the surgeon who outlines the rim of the orbit with his thumb and compresses the supra-orbital artery from below.

The skin, the subcutaneous tissues, and the periosteum are now elevated from the front face of the sinus and retracted strongly forward and upward. With a V-shaped chisel a line is cut parallel with the rim of the orbit and a quarter of an inch above it. (Fig. 122.) This opens the sinus and extends horizontally the full width of the front wall. With a flat chisel and a rongeur the whole of the front wall above this line is removed, leaving the back wall completely exposed. This is made smooth by the removal of all septa. None of the front wall is left as an overhang at its upper limit where it joins with the posterior wall to make the superior angle of the sinus. The front wall is removed also to its extreme outer limit. Later on in the operation the floor of this outer angle should be removed with equal care. The aim of the operation is to make sure that there shall not be unobliterated pockets anywhere in the sinus. The outer angle of the floor of the sinus is liable to give trouble in this respect. The mucous membrane is thoroughly removed from all parts of the sinus by means of curettes.

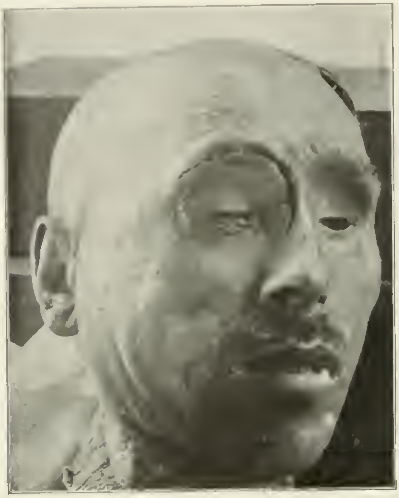


Fig. 121.—The Incision in Killian's Operation. (Original.) The photograph was taken from a cadaver which had been operated upon by Killian at the Harvard Medical School.

In the second stage of the operation the following steps are taken:—The periosteum is entirely removed from the outer half of the nasal bone and the whole of the ascending process of the superior maxilla. With a thin periosteal elevator, curved on the flat, the lachrymal sac is turned from its bed and the periosteum is loosened from the inner wall of the orbit over the anterior two-thirds of the os planum. The periosteum is loosened from the roof of the orbit as well; this being accomplished by swinging the curved elevator behind and to the outside of the pulley of the superior oblique muscle. The pulley is attached to the periosteum of the orbit and through this to a small part of the floor of the orbit just internal to the supra-orbital notch, or three-fourths of an inch from the median line of the head. As the elevator loosens the periosteum from the roof of the orbit the pulley is displaced with it. (Figs. 123, 124, and 125.) The pulley through the periosteum, however, has a firm attachment to the edge of the rim of the orbit, and the attachment extends a little way up on the front face of the rim. This external attachment of the pulley is relied upon to preserve the function of the muscle. Dissections show that, in the Killian operation, the elevator pushes the pulley downward and forward, leaving it hanging from the edge of the rim of the orbit. If the bleeding is troublesome, at this or at any

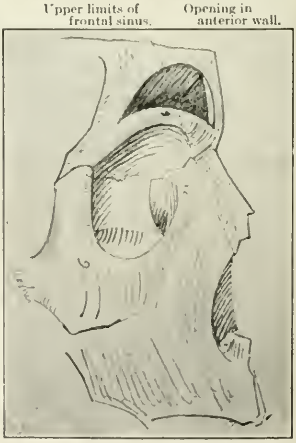


Fig. 122.—The Killian Operation, establishing an opening in the anterior wall of the frontal sinus. (Original.)

other stage of the operation, the wound is packed for a moment with gauze saturated with hot saline solution. With a small V-shaped chisel a line is cut along the outer border of the nasal bone throughout its entire length. From the top of the nasal bone this line is carried upward and outward to the rim of the orbit. This line becomes the lower edge of the bridge and runs diagonally through the internal angular process of the frontal bone. The upper part of this process becomes the bridge; the lower part is removed later with the rongeur, and contributes its share to the opening in the ethmoidal region. At the level of the bottom of the lachrymal groove a horizontal line is cut through the base of the ascending process of the superior maxilla, and this process is removed. The lachrymal sac and the globe of the eye are held retracted outward. With thin-bladed bone forceps the lachrymal bone is removed, as well as the anterior half of the os planum, as far back as the anterior ethmoidal vessels. (Fig. 126.) The ethmoidal labyrinth is now thoroughly exposed, so that the anterior and the posterior ethmoidal cells can be removed with a light punch or with the curette.

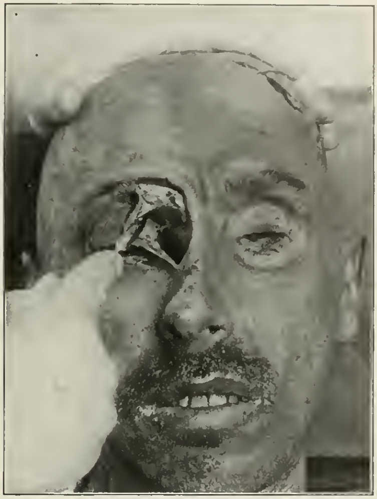


Fig. 123.—Further Steps in the Killian Operation. (Original.) Freeing the periosteum from the roof of the orbit. (From a cadaver operated upon by Killian at the Harvard Medical School.)

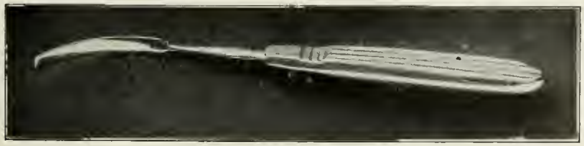


Fig. 124.—Killian's Periosteal Elevator and Eye Retractor.

Killian makes it a routine practice to open the sphenoidal sinus. Between the two bone openings which have been made, a strip of bone a quarter of an inch wide is left as a bridge in order to minimize deformity. This bridge is made from the upper half of the internal angular process of the frontal bone. After the bridge is formed the greatest care must be taken not to break it. (Fig. 127.)

So far in the operation the anterior wall of the frontal sinus has been removed, the duct of the sinus has been obliterated by the removal of the anterior ethmoidal cells, and the opening of the duct into the sinus has been enlarged by the removal of the tip of the ascending process of the superior maxilla and

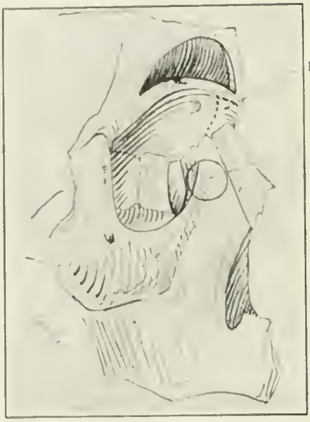

Internal angular process of the frontal bone.
Position and relative size of the initial bone opening in ascending process of superior maxilla.

FIG. 125.—The Second Stage of the Killian Operation. (Original.)

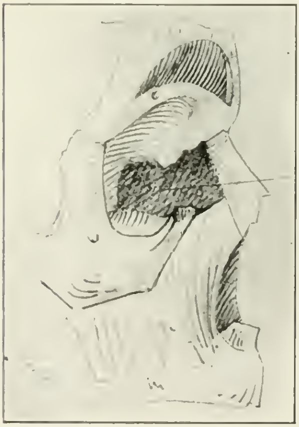

Lachrymal bone and anterior half of the os planum removed to expose the ethmoidal labyrinth.

FIG. 126. The Third Stage of the Killian Operation. (Original.)

the lower half of the external angular process of the frontal bone. The operation is completed by the removal of that part of the floor of the sinus which overhangs the orbit and contributes to the formation of its roof. This is accomplished by working from above downward through the sinus with a small chisel. Especial attention is given to the floor at its outer angle. At this point the floor is often very narrow and hard to remove thoroughly. Often the removal of this part of the floor of the sinus will be found easier to accomplish if the operator stands behind the patient. The whole floor of the sinus is taken away flush with the posterior surface of the orbital rim. (Figs. 127 and 128.) In doing this work the surgeon pushes the pulley of the superior oblique muscle downward and forward; but, as has just been explained, the pulley remains attached to the orbital rim. The superior oblique muscle pulls upward and backward so that the natural action of the muscle tends to bring the pulley back into its proper position, provided the latter is not completely detached. It is of vital importance, therefore, that it should not become detached from the rim of the orbit.

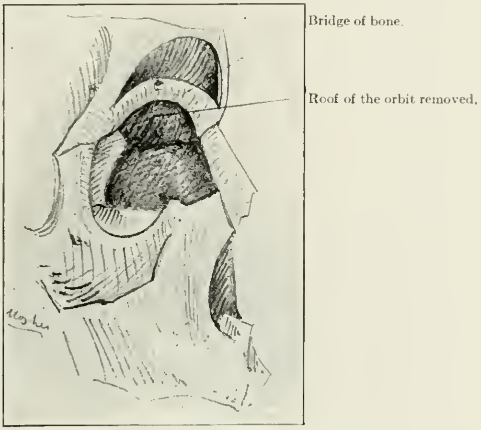


FIG. 127.—The Killian Operation Completed. (Original.)

In one hundred cases Killian reports that he has had only two or three in which double vision followed the complete removal of the floor of the frontal sinus, and in these cases the symptom was only of a temporary character, lasting not longer than three weeks. In a somewhat larger percentage of cases the tests of the ophthalmologist will show some double vision, but the amount is not enough, according to Killian, for the patient to be conscious of its existence.

A small rubber drainage tube, an eighth of an inch wide and perforated at the sides, is placed at the bottom of the sinus and carried down through the nose into the vestibule. On either side of this a strip of gauze is carried up into the ethmoidal region. When the wound made by the skin incision is closed, the corresponding notches made by the cross incisions are brought together and the wound is sutured with fine wire. The eyebrow and the lids are anointed with sterile vaseline, and a small horizontal pad is placed above the eyebrow in order to keep the skin of the forehead forced well back against the posterior wall of the sinus. The eye and the half of the head corresponding to the site of the operation are snugly bandaged.

The rubber drainage tube and the nasal packing are removed at the end of twenty-four hours. After their removal the middle meatus is kept clean by dry swabbing or by syringing. Some of the stitches are removed on the third day, and the remainder on the sixth. The crusting in the nose, which results from the removal of so much mucous membrane, persists for some six weeks. The discharge ceases after the lapse of varying periods of time—six weeks to six months. From the time of the operation onward the middle meatus must be watched with the greatest care. Obstructing tags of the middle turbinate or of mucous membrane should be removed at the earliest possible moment.

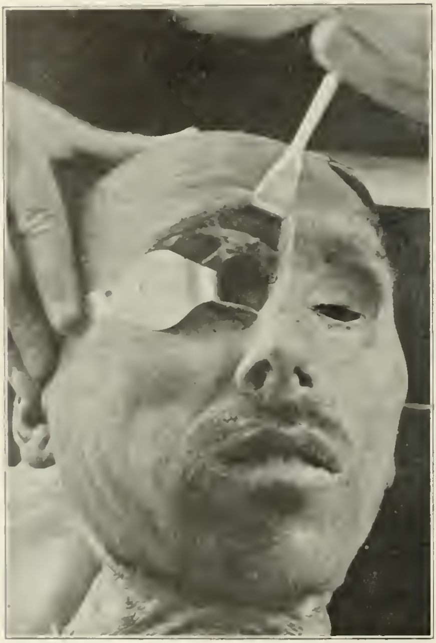


Fig. 128.—The Skin of the Forehead is Retracted Upward and the Eye Outward in Order to Show the Bridge of Bone Left between the Frontal and the Ethmoidal Bone Incisions. The photograph was taken from a cadaver operated upon by Killian, at the Harvard Medical School. (Original.)

The Method of Operating Employed by the Writer.—The method which I have been accustomed to use aims, not to obliterate the sinus, but to turn it into a cavity freely communicating with the nose, and to make this cavity as large as the anatomical structure of the sinus will permit. A small sinus operated upon in this way probably in time becomes obliterated; but, in the case of a large sinus, only the prolongations and the outlying edges become obliterated, the body of the sinus about the naso-frontal duct becoming a cicatrized, non-secreting cavity which communicates with the nose. Only so much of the front wall of the sinus is removed as is sufficient to enable the operator to explore the whole of the sinus and to remove thoroughly the septa and all of the mucous membrane. In the case of a small sinus this means that the whole of the front wall, except the part left for a bridge, is taken away; but in a large sinus it is seldom necessary to remove more than one-half of the anterior wall. It is imperative to remove not only the internal part of the floor of the sinus where it merges into the opening of the naso-frontal duct, but also the outer portion which overhangs the orbit.

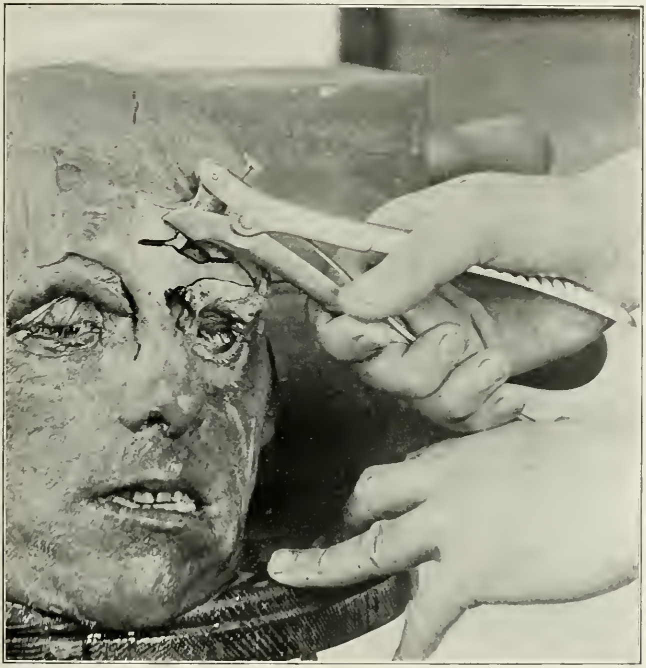


FIG. 129.—The De Vilbiss Bone Forceps. The photograph shows the linear incision made by this instrument and the manner in which the latter should be used. The instrument is about to start a new incision—one that branches from the first incision near its inner end. (Original.)

Detailed Description of the Operation.—The dimensions of the sinus, we will assume, have been determined previously by the *x*-ray plate. Suppose, for the sake of example, that this shows the sinus to be a large one. As the first step, the choana is tamponed through the nose, and the nose itself is plugged up to the middle turbinate. An incision is made through the skin the whole length of the centre of the eyebrow and carried down the side of the nose along the outer border of the nasal bone to its lower edge. The skin over the front face of the sinus is dissected free. A quarter of an inch above the rim of the orbit an incision is made through the subcutaneous tissues and the periosteum down to the bone, and carried outward parallel with the edge of the orbit. Above this incision the periosteum and the subcutaneous tissues are stripped from the whole of the front face of the sinus and retracted strongly forward and upward. A little to the outer side of the median line, at the inner end of the periosteal incision, a small opening is chiselled into the sinus, and the size of the latter verified with a probe. The exploratory incision is then made large enough to admit the De Vilbiss bone-cutting forceps (Fig. 129), and a line is cut through the front wall of the sinus (following the periosteal incision) to within a quarter of an inch of the outer limit of this cavity. This incision should be at least a quarter of an inch above the rim of the orbit and

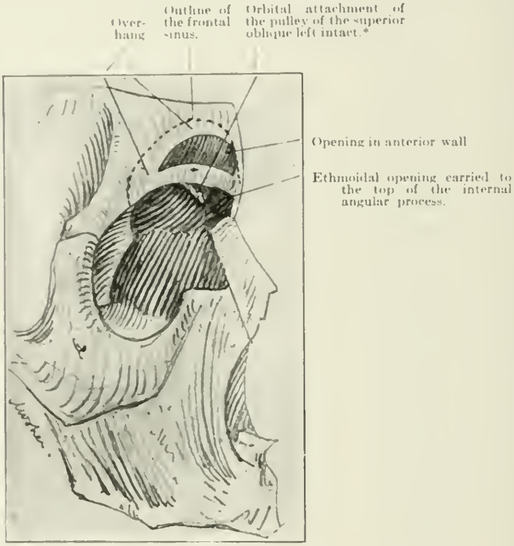

Over-hang
Outline of the frontal sinus.
Orbital attachment of the pulley of the superior oblique left intact.*
Opening in anterior wall
Ethmoidal opening carried to the top of the internal angular process.

FIG. 130.—The Operation Used by the Writer.

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* The author no longer leaves this part of the floor of the sinus, but takes away all of the floor.

parallel with it. With rongeur and chisel an oblong opening is made in the front wall of the sinus large enough to enable the operator to explore the whole of the sinus and to remove thoroughly the septa and all of the mucous membrane. No matter how much of the front wall may have to be taken away for the purpose, the opening should be large enough to render these procedures possible. In a large sinus it will be found necessary, in order to accomplish these two things, to remove a little more than one-half of the front wall. Above the opening a little of the front wall is left as a rim or overhang. Both to the outside of the opening and below it as well some of the front wall is left as an overhang. (Fig. 130.) The object of leaving the overhang is to provide a bridge for supporting the skin of the forehead and to minimize the deformity which results from its falling in. Unless enough of an overhang can be left to prevent the skin from attaching itself to the posterior wall of the sinus and thus establishing a non-draining pocket under the overhang, no overhang should be left. My experience has been that in sinuses of moderate size a sufficient overhang can be left to prevent the production of pockets. In a sizable sinus it is easy to leave an overhang which is so large that there is no possibility of trouble. The long axis of the opening in the front wall of the sinus should be parallel with the orbital rim, so that the furrow made by the sinking of the skin re-enforces the natural prominence of the superciliary ridge. In a small sinus no overhang is left at the superior angle of the front wall, and the skin is allowed to fall back and to obliterate as much of the sinus as it will. In a

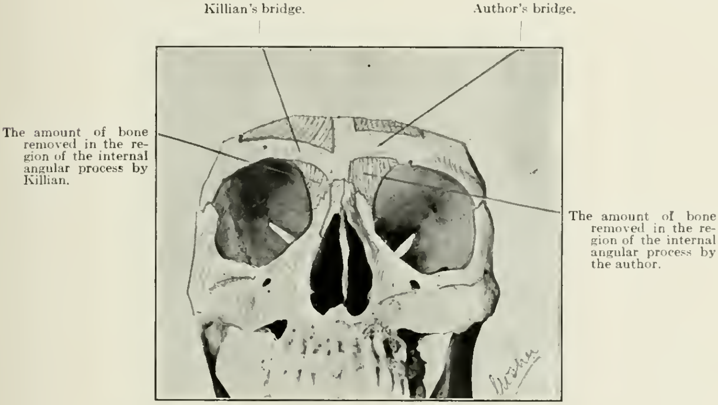
Killian's bridge.
Author's bridge.
The amount of bone removed in the region of the internal angular process by Killian.
The amount of bone removed in the region of the internal angular process by the author.

Fig. 131.—Photograph Showing the Position of the Bridge in the Operation Used by the Writer. The upper part of the ascending process of the superior maxilla has not been removed. In the operation this is taken away in order to get at the internal angular process of the frontal bone so that this may be removed from below upward.

sinus of moderate size, where the overhang method is employed, the deformity is less than by any other method. Occasionally, even in a large sinus, the deformity is so slight as to be barely noticeable.

After a sufficient opening has been made in the front wall and the interior of the sinus has been thoroughly dealt with, the lower part of the skin incision over the internal angular process of the frontal bone and along the outer border of the nasal bone is carried through the periosteum. At the root of the internal angular process of the frontal bone, for a distance of a quarter of an inch above the rim of the orbit, the subcutaneous tissue and the periosteum are not cut through. At this point the bridge is to be made. Killian makes the bridge out of the upper half of the internal angular process. (Fig. 131.) In this operation the bridge is made a little higher and entirely from the superciliary ridge. The periosteum is left on the bridge in order that it may have sufficient nourishment. A number of times, however, I have seen it destroyed, and yet no harm resulted. The periosteum is now removed from the outer half of the nasal bone, the ascending process of the superior maxilla, and the lower half of the internal angular process of the frontal bone. The lachrymal sac is turned from its bed partly by blunt dissection with a small curette or a small periosteal

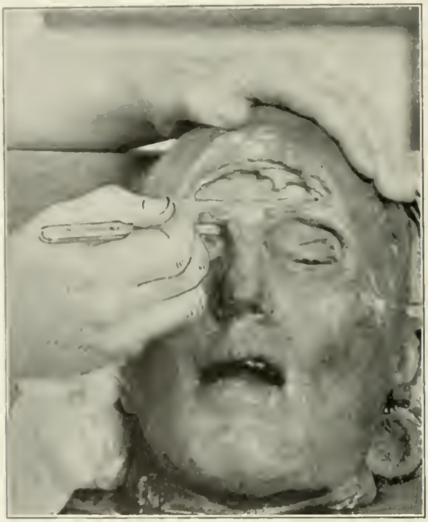

Fig. 132.—The Periosteum has been Elevated from the Lachrymal Bone and the Os Planum, and the Elevator is Carried Upward and Outward until it is Stopped by the Pulley of the Superior Oblique Muscle. Unless excessive force is used the resistance of the pulley is sufficient to bring the instrument to a halt. (Original.)

elevator curved on the flat, and partly by sharp dissection. The field should be rendered as bloodless as possible and the dislodging of the sac should not be hurried. I have had subsequent trouble with the lachrymal sac in only two instances, and in those cases the trouble lasted for only a few weeks. The sac is turned from its bed until the bottom of the groove in which it lies is fully exposed. Unless the elevator is held parallel with the inner wall of the orbit it is very easy to perforate the lachrymal bone. No harm results from this; it simply causes some delay in the dissection of the periosteum over the os planum.

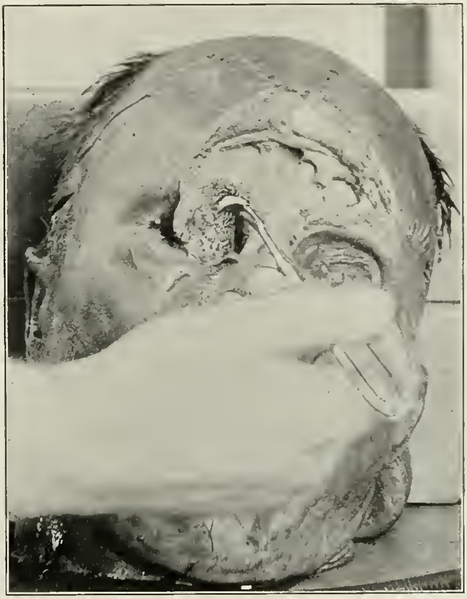

Fig. 133.—Elevating the Periosteum from the Roof of the Orbit. The photograph shows how the pulley of the superior oblique muscle is dislocated forward when the periosteum is displaced, but remains attached to the rim of the orbit. (Original.)

The lachrymal sac comes out of its bed somewhat slowly, but the periosteum over the os planum is easily and quickly separated from the underlying bone. In the same vertical line with the lachrymal sac, or three-quarters of an inch from the median line, at the upper part of the inner wall of the orbit, the periosteal elevator encounters the resistance of the pulley of the superior oblique muscle, and the further elevation of the periosteum from the rim of the orbit is stopped. The pulley will stand considerable pressure without being detached, and readily brings the elevator to a halt unless excessive force is employed. (Figs. 132, 133, 134, and 135.) The periosteum is next elevated from the roof of the orbit over an area corresponding to the floor of the frontal sinus.

The lachrymal sac and the globe of the eye are now retracted outward and held in this position. The point of the countersink which comes with the

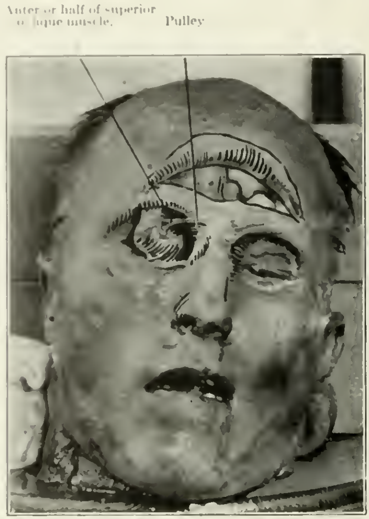

Fig. 134.—Dissection of the Anterior Half of the Superior Oblique Muscle. (Original.)

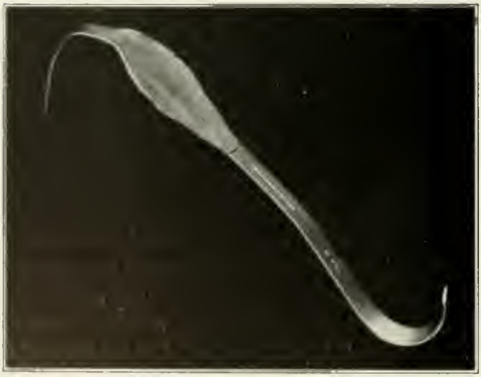

Fig. 135.—Malleable Eye Retractor with Eye Shield, for Retracting the Eye in the Killian Operation. (Original.) As the handle can be bent, it can be made to lie against the cheek, out of the way of the operator.

Krause set of burrs is placed in the middle of the ascending process of the superior maxilla, and a start is made preparatory to the use of the burr. A burr is then placed in the notch made for it and driven through the bone. (Fig. 125.) The opening in the bone should never be large enough to extend through the side of the nasal bone to the bridge of the nose. If this is done, not only will the skin over the side of the nose pit, but the bridge of the nose will fall. Where the ascending process of the superior maxilla is of good size the opening should extend upon the nasal bone but little.

A right-angled punch is placed in the opening made by the burr, and the stump of the ascending process of the superior maxilla is levelled to the bottom of the lachrymal groove. (Figs. 136, 137, and 138.) Then the punch is turned upward and the internal angular process of the frontal bone is bitten away up to the level of the rim of the orbit. It is a vital part of the operation to remove the lower part of the internal angular process of the frontal bone at the point where the tip of the ascending process of the superior maxilla articulates with it. From the naso-frontal duct forward, the floor of the frontal sinus overhangs the inner part of the orbit. The amount of the overhang varies with the size of the sinus. From the duct forward, the floor of the frontal sinus is made first by the apex of the ascending process of the superior maxilla and then by the root

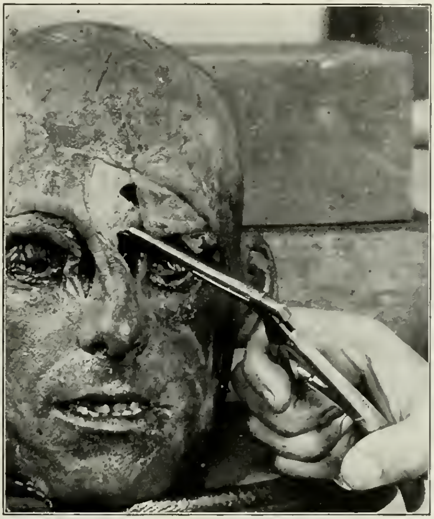

FIG. 136.—The Photograph Shows the Manner of Removing the Upper Part of the Internal Angular Process of the Frontal Bone by Means of Right-angled Punch. (Original.)

of the nasal bone. The tip of the ascending process of the superior maxilla articulates with the under surface of this overhang. Except in very large sinuses the posterior edge of the ascending process of the superior maxilla makes the anterior boundary of the duct of the sinus. In order to enlarge the duct forward and to do away with the overhang made by the floor of the sinus in front of the duct, it is necessary to remove the top of the ascending process of the superior maxilla and the portion of the internal angular process of the frontal bone which articulates with it. The greater the extent to which the internal angular process of the frontal bone is removed, the larger the opening from the sinus into the nose becomes. (Figs. 131 and 138.) In a sinus with a saucer-shaped floor the naso-frontal duct is placed so far back that it is necessary to chisel into the sinus at the top of the ascending process of the superior maxilla, because the rectangular forceps cannot get a bite. The sinus once entered at this point, the rest of the floor back to the duct is removed either with the forceps or with the chisel. It is often useful to keep a probe in the duct to serve as a guide as the floor is being removed back to it. The internal angular process of the frontal bone is next removed to the middle line, flush with the septum. For this

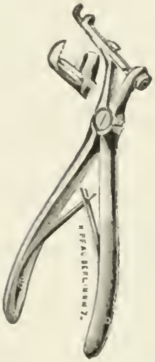

Fig. 137. Bone Punch for Working About the Stump of the Ascending Process of the Superior Maxilla and for Removing the Internal Angular Process of the Frontal Bone. (Cittelli.)

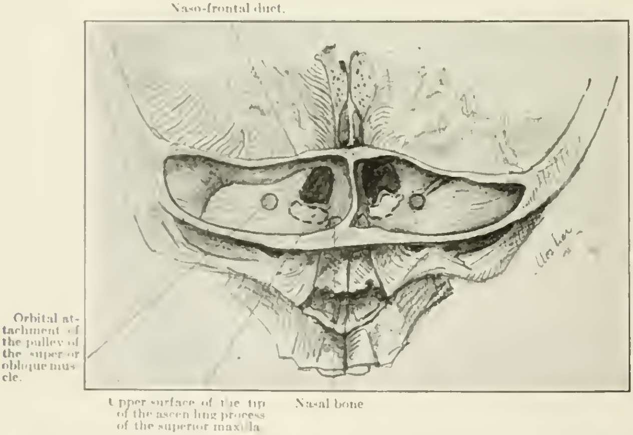
Naso-frontal duct.
Orbital attachment of the pulley of the superior oblique muscle.
Upper surface of the tip of the ascending process of the superior maxilla
Nasal bone

Fig. 138.—A Horizontal Section of the Skull, Giving a View of the Frontal Sinuses from Above. (Original drawing, showing the parts reduced to three-quarters their natural size.)

On the floor of the frontal sinus may be seen the location of the tip of the ascending process of the superior maxilla and the upper end of the nasal bone which articulates with it. The drawing also shows how the ascending process of the superior maxilla constitutes the anterior boundary of the naso-frontal duct.

the chisel is necessary. The bridge of bone which is left for the purpose of preventing deformity is made out of the superciliary ridge, its lower edge being at the level of the supra-orbital notch; that is, at the level of the upper edge of the orbit. Thus, the whole of the internal angular process of the frontal bone is taken away. The bridge which is left should be as wide as it possibly can be, never less than a quarter of an inch.

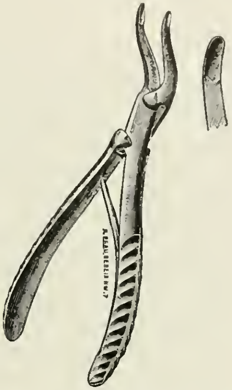

FIG. 139.—Bayonet-shaped Bone Forceps. (Jansen.) This instrument is useful for removing the os planum and the inner part of the floor of the orbit.

Except in large sinuses the posterior edge of the ascending process of the superior maxilla is the anterior border of the duct of the frontal sinus. Therefore, it is the surest guide to a small sinus. By removing the lachrymal bone and passing a curved probe upward and forward round the tip of the ascending process of the superior maxilla (see Fig. 119), the sinus can best be found.

With thin-bladed bone forceps, like the Jansen forceps used for submucous resection of the septum, the lachrymal bone and the anterior half of the os planum are removed as far back as the anterior ethmoidal vessels. (Fig. 127.) Until the landmarks become clear it is well to remove the os planum from below upward. The duct of the frontal sinus comes down through the anterior ethmoidal cells, just to the inside of the lachrymal bone. By removing the lachrymal bone and the anterior part of the ethmoidal labyrinth the duct of the sinus is destroyed and a large open space is left in its place.

The floor of the frontal sinus, as it extends outward over the orbit, is now to be dealt with. The os planum is followed upward and outward with a pair of curved bone forceps, and the part of the floor just within the supra-orbital notch is removed. (Figs. 138 and 139.) The removal of the rest of the floor should be accomplished by working from above, chiselling from the sinus down into the orbit. Where the sinus has an orbital prolongation the upper edge of the os planum should be followed back to the limit of this. The larger the orbital prolongation, the larger the opening which can be made from the sinus into the nose. In attempts to obliterate the frontal sinus an orbital prolongation is not a help, as it is in this case, but a hindrance. (Figs. 140, 141, and 142.) At times an ethmoidal cell projects like a mound upward and outward over the posterior part of the orbit. The posterior wall of the orbital prolongation of the frontal sinus constitutes the anterior wall of such an ethmoidal cell. The floor of the frontal sinus makes the anterior part of the floor of the orbit, and the ethmoidal cell makes the posterior part. Such an ethmoidal cell can be recognized and dealt with only by following the os planum upward and outward.

It is better to remove the middle turbinate under cocaine before the operation upon the sinus is begun. If this has not been done the operator should push the middle turbinate upward and outward into the operative field. The turbinate tends to lie against the septum. The operator should remember that he is working at a higher level than the body of the turbinate. It is therefore easily possible to leave the greater part of the turbinate in place if this point is not borne in mind. The posterior ethmoidal cells are curetted out by following the posterior part of the os planum backward. Occasionally an ethmoidal cell runs backward to the outside of the sphenoidal sinus and parallel with it. This cell may be as large as the cavity of the sphenoidal sinus itself and may therefore be mistaken for it. In order to make sure that this does not happen, the curette should be carried backward, the septum being taken as a guide. If this falls into a new cavity, the first one was an ethmoidal cell, the second the sphenoidal sinus. When it can be done easily it is better to explore the sphenoidal sinus after the ethmoidal cells are removed. The cribriform plate projects downward like a mound to within an eighth of an inch of the inner canthus, and in doing this it makes a rib which projects into the upper part of the nose to the outside of the olfactory slit. The projection which it makes might be easily opened with forceps or curette if any work is done at the level of the top of the septum. For this reason all work centres about the os planum.

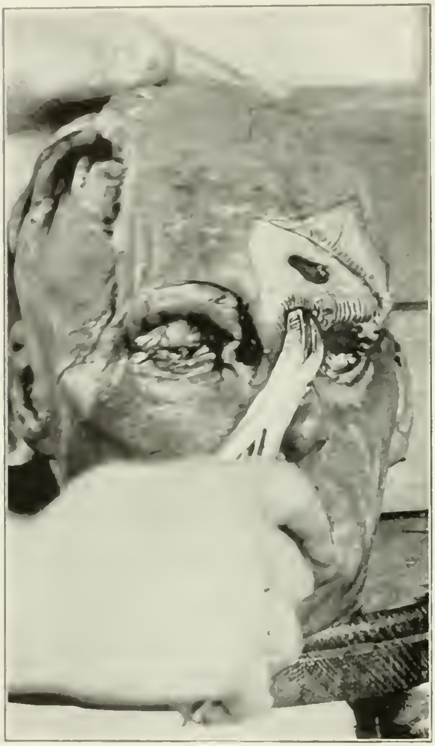

FIG. 140.—The Photograph Shows the Method of Using the Bayonet-shaped Rongeur (see Fig. 139) for the Removal of the Inner Part of the Roof of the Orbit, where it Constitutes the Floor of the Frontal Sinus. (Original.)

The vital points in the radical frontal-sinus operation are the removal of the whole of the floor and the removal of the whole of the internal angular process of the frontal bone. The thorough removal of the internal angular process I believe to be of supreme importance. It has been customary to take away only the lower part of it, not the whole. By no other procedure can the naso-frontal duct be dealt with so satisfactorily. The frontal sinus is packed with a small strip of gauze, and the skin incision is closed except at the inner end, where two provisional sutures are left at the point where the packing comes out. The ethmoidal region and the nose are packed with a single strip of gauze. All packing is covered with Cargile membrane. The ethmoidal packing is adjusted in its place by forceps placed in the ethmoidal wound, and the packing is pressed away from the stump of the ascending process of the superior maxilla so that it shall not catch on this when it is removed and leave behind a piece of gauze to act as a foreign body. The nasal packing is made of one strip so that no gauze shall be lost in the nose. The packing is brought down to the vestibule. The sutures used are horsehair alternating with fine silkworm gut. A conical plug of gauze is placed in the inner angle of the orbit over the lachrymal sac, in order to force this back into

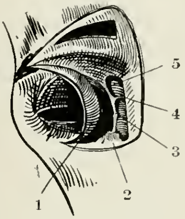

FIG. 141.

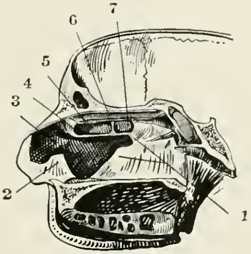

FIG. 142.

FIG. 141.—The Killian Operation. (Original.) 1, Eye retracted outward; 2, stump of the ascending process of the superior maxilla and the posterior part of the os planum. The anterior part has been removed; 3, ethmoidal cell (see Fig. 96) rising up like a mound over the posterior part of the orbit; 4, anterior face of this ethmoidal cell; 5, frontal sinus.

The drawing shows how it is possible, by following the os planum upward and backward, to recognize an ethmoidal cell which is protruding like a mound over the roof of the orbit posteriorly, and to open it. By approaching such a cell through the frontal sinus the anterior wall of the cell would appear to be the posterior wall of the frontal sinus and therefore the anterior wall of the cranial cavity, and no operator would care to open through it.

FIG. 142.—Diagram to Illustrate how an Ethmoidal Cell (7) May overlie the Posterior Part of the Orbit. (Original.) Such a cell would have a common wall with the frontal sinus (4). The posterior wall of the frontal sinus is the anterior wall of such a cell (7). Only in the fronto-ethmoidal operation could such a cell be dealt with.

The figure is drawn from a specimen on which the Killian operation had been done 1, The posterior part of the septum; 2, the stump of the ascending process of the superior maxilla; 3, the dark area represents the space left by the removal of the lachrymal bone and the anterior half of the os planum; 4, the frontal sinus opened from below; 5, the ridge formed by the projecting downward of the cribriform plate; 6, the roof of the olfactory fissure; 7, ethmoidal cell overlying the posterior part of the orbit.

Only by following up the os planum from below would it be possible to recognize such a cell (7) and to open and drain it. As the cribriform plate projects downward (5) in a ridge near the septum, it is not safe to work about the upper part of the septum for fear of perforating this ridge. All work should have the os planum as a guide. It is safe to follow this up, but not the septum.

its place. The eyebrow and the eyelids are smeared with sterile vaseline, and a snug bandage is applied.

The After-Treatment. From the moment when the patient comes out from under the influence of the anæsthetic the tongue should receive constant care. On the day following the operation the nasal packing is removed, and on the second day after the operation the packing is removed from the sinus, the latter is washed free from clots, and the provisional sutures are tied. The eye is washed daily with warm boracic-acid solution, and the lids are anointed with a one-per-cent corrosive ointment. Operative œdema of the lids generally closes the eye for three or four days. The middle meatus should be watched with great care. On the second day it should be cleaned out with forceps and swab. The nose is to be sprayed with an alkaline spray twice a day. A part of the stitches are removed on the third day, and the remainder on the sixth day. The head bandage is then replaced by a cocoon. The patient can leave the hospital in from ten days to two weeks. Early and constant care of the middle meatus is the price which it is necessary to pay for a successful operation.

If the ethmoidal region has been extensively cleared out there will be considerable crusting for some weeks (three to six). The crusting gradually disappears under the use of argyrol (twenty-five per cent to fifty per cent). It may be some months before the discharge entirely ceases. This is to be expected, because the raw surfaces made by the operation are so extensive that a considerable time is required for new mucous membrane to cover them over.

Complications. The smaller the sinus and the smaller the opening which it is possible to make into the nose, the greater the care which it is necessary to take in order to maintain drainage. Blood-clot and tags of middle turbinate are the things which give trouble. If, in the case of a large sinus, it becomes necessary to reopen the brow incision on account of poor drainage, it should be possible, after irrigating the sinus for a few days and cleaning out the middle meatus more thoroughly, to close the sinus again. In a small sinus, however, granulations spring up so rapidly that it may become necessary to obliterate the sinus by means of granulations. The complication which every operator dreads is meningitis from injury of the cribriform plate. No work should be done about the upper edge of the septum, because here the cribriform plate projects downward to receive it. The posterior internal angle of the duct of the sinus is also in contact with the cribriform plate. Therefore no curetting should be done in this region. All work should be confined to the upper and the lower parts of the os planum and to the internal angular process of the frontal bone. The only harm which can be done in that region is the possible removal of the attachment of the pulley of the superior oblique muscle. If the lachrymal sac is torn or becomes infected, the tear duct becomes blocked. Should this prove to be permanent the sac will have to be extirpated, but the necessity for this step ought not to be decided upon until at least six months shall have elapsed. No probing should be undertaken, because the sac has lost a part of its bony wall, and consequently there is nothing which can serve to guide the probe. Argyrol (twenty-five per cent to fifty per cent), dropped into the eye once daily, is often of use. The infection in the sac may be kept up by the condition in the nose. If such be the case, improvement may be expected only as the nasal condition improves.

PROPER METHOD OF PROCEDURE IN THE CASE OF A SMALL SINUS.—If the frontal sinus does not extend into the brow far enough to permit an opening to be made in the front wall and still leave a bridge above the inner end of the rim of the orbit, no opening should be made in the upper part of the front wall of the sinus, but the sinus should be treated from below. The internal angular process of the frontal bone can be taken away without deformity resulting; but if the front wall of the sinus just above the internal angular process is taken away, without leaving a bridge at the level of the upper edge of the orbit, noticeable deformity results. A vertical furrow gives greater deformity than a furrow which is parallel with the superciliary ridge. When the operator does not know the size of the frontal sinus, either because the x-ray plate is poor or because he is without one, the ethmoidal part of the operation should be done first and the location of the sinus and its size determined from below. The inferior method of approaching the sinus can be used for exploring the sinus when the operator wishes to find out its condition. A normal sinus explored from below is not so liable to infection as it is when it is explored through the front wall.

Operation.—The operation for a small sinus which does not extend into the brow far enough for a bridge to be made, is the operation just described for the ethmoidal part of the radical frontal-sinus operation. Where there is no bridge to be left, one can go a little higher than the internal angular process of the frontal bone, well into the rim of the orbit.

Punctured Wound of the Frontal Sinus.—In a simple punctured wound of the frontal sinus the skin wound should be cleaned. An ice bag placed over a thin bandage might have some effect in stopping bleeding in the sinus. If symptoms of sepsis appear the sinus should be explored and a large opening made down into the nose. If it is not possible to do this, the inner angle of the floor of the sinus should be removed by the ethmoidal route.

Simple Depressed Fracture of the Anterior Wall of the Frontal Sinus.—In a simple depressed fracture of the front wall of the frontal sinus, the bone fragments should be raised into place by making an incision in the skin and inserting a small hook under the fragments. If this can be done without penetrating the mucous membrane of the sinus, so much the better. An attempt should be made to prevent the sinus from becoming filled with blood, because the clot which forms very readily becomes septic.

Compound Depressed Fracture of the Frontal Sinus.—In a compound depressed fracture of the frontal sinus, enough bone should be removed to allow the sinus to be washed clean. Then the fragments should be raised into place and the sinus lightly packed with a strip of gauze covered with Cargile membrane. This is to be removed on the second day, and the cavity of the sinus again washed out. Great care is necessary in dealing with the duct of the sinus, especially if it is a small one, because the abraded mucous membrane of the duct is very likely to give trouble through closure of its lumen. After the packing has been removed, the sinus should be washed through the wound for a day or two. If the sinus does not become infected, the skin opening may be allowed to close on the fifth or sixth day.

V. THE APPLIED ANATOMY AND THE DISEASES OF THE ANTRUM.

Anatomy.—The antrum is formed by an outgrowth of the nasal mucous membrane at the fourth month of fœtal life. As it is the first of the accessory sinuses to be formed, it is, naturally, when growth is complete, the largest. At birth it is of about the size and shape of a split coffee bean. In the adult it occupies the body of the superior maxilla. The cavity of the sinus has the form of a pyramid; its base lies inward and makes one half of the outer wall of the nasal fossa; the apex points outward and upward toward the malar bone. The sinus does not attain any considerable size until the second teeth begin to erupt. From this time forward it enlarges rapidly. Faulty eruption of the teeth influences its growth markedly.

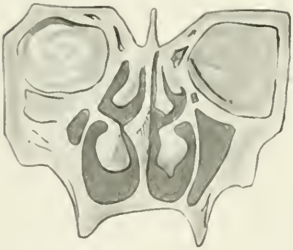

Fig. 143.—This Figure Shows Inequality in the Size of the Two Antra, the Left Antrum Being much Smaller than the Right. Hajek.

Absence of the Antrum.—The antrum is rarely absent.

Size.—The two antra are often of unequal size, but it is not common to have either one so small that it cannot be found. (Fig. 143.) From the sixth year on to puberty, the two antra may enlarge unequally. When this occurs, one side of the hard palate is higher than the other. This inequality in the growth of the antra is a prominent cause of vomer spurs on the septum. The antrum enlarges more in a downward direction than it does from side to side. The cubic contents of the normal antrum may be given as 11 or 12 c.c.—that is, it holds about three drachms of fluid. In some instances the antrum may be twice as large (25 c.c.). In such a case the cavity may hold an ounce.

Complete Partitions.—Complete partitions are very rare.

Partial Partitions.—The antrum often has partial partitions. These have generally to do with the tooth roots, and so are found on the floor of the sinus. They cross the sinus from side to side, being roughly parallel with the anterior face. These partial partitions are found also in the anterior internal angle of the sinus, where the front wall joins the inner wall.

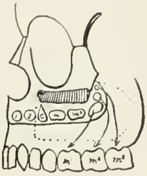

FIG. 144.—Diagram to Show the Change in the Position of the Molar Teeth as They Swing Down into Place by the backward and downward growth of the tuberosity of the antrum. The third or last molar is the wisdom tooth. This occasionally does not get fully into place, and erupts in such a manner as to require surgical interference. (Keith.)

THE RELATION OF THE TEETH TO THE ANTRUM.—In infancy the molar teeth are embedded in the tuberosity or in the posterior face of the antrum. All the rest of the teeth are embedded in the anterior face. As the tuberosity grows backward and downward the molar teeth are brought into place. (Fig. 144.) Owing to defective growth of the tuberosity, the third upper molar, the wisdom tooth, occasionally erupts at a vicious angle. Through faulty eruption the anterior teeth are liable to penetrate the antrum. Bony cysts may form about the sacs of these teeth.

THE WALLS OR FACES OF THE ANTRUM.—*The Anterior Face.*—The anterior face of the antrum is divided into two fossæ by the vertical ridge made by the canine tooth. To the inside of this and below the nasal notch there is a small depression called the incisor fossa. (Fig. 145.) The incisor teeth are below it. To the outside of the canine tooth, the canine fossa, which is much larger than the first fossa, occupies the rest of the anterior face. Below, this fossa corresponds to the incisor tooth, the two bicuspids, and the first molar. The bone in the centre of the incisor fossa is very thin. In the upper part of the anterior face, an eighth of an inch below the middle of the lower rim of the orbit, there is a sizable foramen through which the infra-orbital nerve and artery reach the tissues of the cheek.

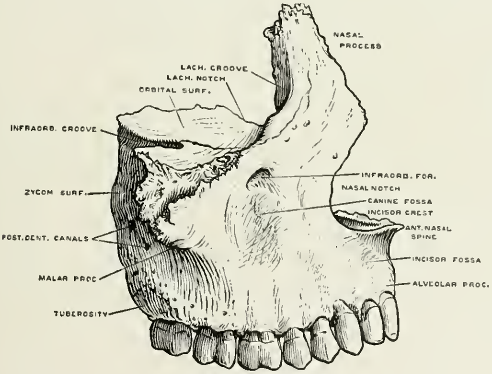

FIG. 145.—Right Superior Maxillary Bone as Seen from the Outer Side. (Quain.)

The Posterior Face.—The posterior face of the antrum is thick and rough and ends below in a rounded projection called the tuberosity. This face has a few small openings for the posterior dental nerves, which spring from the superior maxillary nerve as it bridges across the spheno-maxillary fossa. (Fig. 117.)

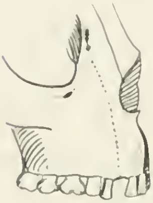

Fig. 116.—A Small Canal through the Anterior Face of the Antrum. Through such a canal sepsis from a tooth might infect the tissues of the cheek at the inner angle of the eye and simulate an abscess of the lachrymal sac. (Sieur and Jacob.)

The Superior Face.—The superior face of the antrum makes the greater part of the floor of the orbit. Like the anterior face, it is thin and easily perforated. Running forward in the middle of this face there is a gutter for the infra-orbital nerve. Half-way to the anterior edge of the superior face this gutter becomes a closed canal.

The Inferior Face.—The inferior face of the antrum is more of a thick ridge than a face. It is the base of the alveolar process and merges into it. The alveolar process supports the teeth. The floor of the antrum usually extends forward to the first bicuspid. Occasionally the floor barely covers the three molars.

The Internal Face or the Base of the Antrum.—The base of the antrum, seen from within this cavity, is quadrilateral. Running from the anterior superior angle downward to the middle of the posterior side of this face is an oblique line which represents the attachment of the inferior turbinate. (Figs. 148, 149, and 150.) The attachment of the inferior turbinate divides the base of the antrum into two triangles—an upper triangle which is opposite the middle meatus, and a lower triangle which is opposite the inferior meatus. In the anterior superior part of the upper triangle is situated the drainage opening of the sinus—the ostium. From the ostium backward the rest of this triangle is membranous. The antrum drains best when the person is lying down and the head is resting on its side. In the upright position of the body the antrum can be made to drain by bending the head forward and sharply to the opposite side.

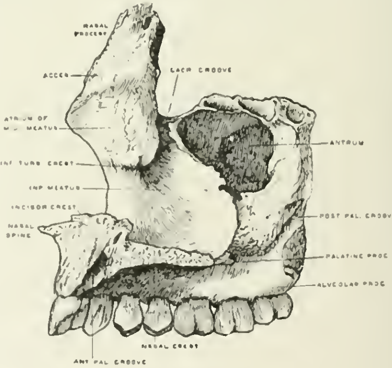

Fig. 117.—Right Superior Maxillary Bone.—Seen from the Inner Side. (Quain.)

A curette passed into the nose through the ostium would strike the bottom of the ethmoidal labyrinth. (Figs. 67 and 75.) If it should be carried directly backward through the upper part of the membranous area of the superior triangle it would strike, in order, the ethmoidal bulla, the posterior cells, and then the front wall of the sphenoidal sinus. In the anterior part of the inferior triangle there is an oblique swelling made by the projection outward of the lachrymal canal. In front of this the wall of the antrum is thick, because at this point it is made by the thick root of the ascending process of the superior maxilla.

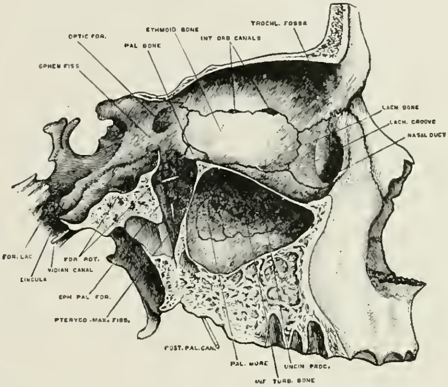

FIG. 148.—Sagittal Section of the Facial Portion of the Skull. This section shows the inner wall of the antrum and the speno-maxillary fossa. (Quain.)

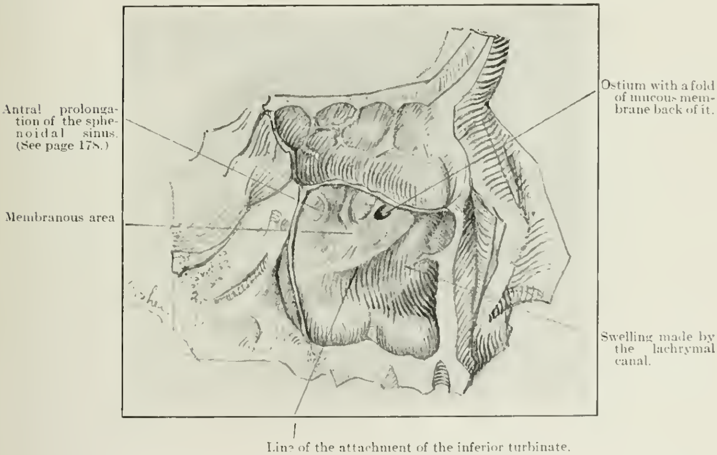
Antral prolongation of the sphenoidal sinus. (See page 178.)
Membranous area
Ostium with a fold of mucous membrane back of it.
Swelling made by the lachrymal canal.
Line of the attachment of the inferior turbinate.

FIG. 149.—The Inner Wall or Base of the Antrum as Seen from within the Cavity. (Original.) (Three-fourths natural size.)

In a backward direction from the lachrymal duct the wall of the inferior triangle grows thin, especially at its upper limit close to the attachment of the inferior turbinate.

The Internal Face of the Base of the Antrum Seen from the Nose.—Looked at from the nose the internal face of the antrum is seen to constitute the outer wall of the inferior meatus and the lower half of the outer wall of the middle meatus. The inferior turbinate runs horizontally across the lower part. The middle turbinate hides the upper part. (Fig. 151.) When this is removed the markings on the upper part of the inner wall of the antrum can be seen. These are the lower end of the unciform groove, with the ostium hidden in it, and the membranous area of the inner wall, which extends backward from this. Beginning at its upper limit, and overhanging the upper edge of the inner wall, is the ethmoidal labyrinth. The membranous area of the inner wall, therefore, can be used as an approach to the ethmoidal cells.

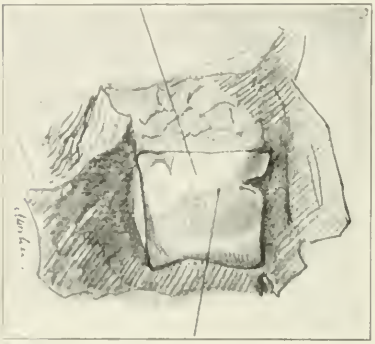

FIG. 150.—The Inner Wall of the Antrum as Seen from within the Cavity. (Original.) (Four-fifths natural size.)

THE INTERIOR OF THE ANTRUM.—The dental nerves spring from the infra-orbital nerve as it runs partly in the floor of the orbit and partly in the roof of the antrum. (Fig. 152.) Small channels for these nerves run in the posterior, the outer, and the anterior walls of the antrum. From the anterior part of the roof of the antrum the canal for the infra-orbital nerve projects down into the sinus like a ridge. The rib made by the projection of the canal for the nerve is often so large that it shuts off a pocket in the superior internal angle of the antrum. (Figs. 153 and 154.) This may connect with the main cavity only by a small opening. The floor of the sinus is often irregular from the projection upward of the tooth roots. At times a tooth root is naked in the antrum.

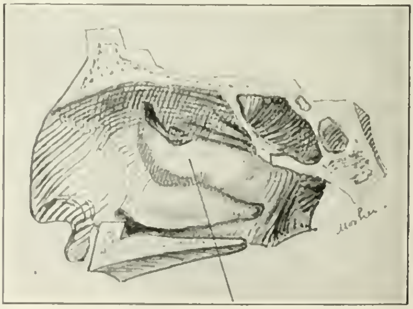

FIG. 151.—The Membranous Area of the Inner Wall of the Antrum as Seen from within the Nasal Cavity. (Original.) (Three-fourths natural size.)

The lowest part of the antrum is back of the second molar tooth, for at this point the floor dips down into a pocket. The floor of the antrum is thickest over the bicuspid teeth. At this place it may measure as much as half an inch in thickness. The thickness of the floor is rarely less than a quarter of an inch unless it is atrophied from the loss of the teeth. In such cases it may be as thin as paper. The floor of the normal antrum is always about a quarter of an inch below the floor of the nasal cavity.

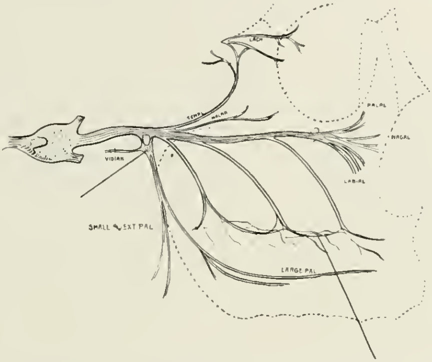

FIG. 152. The Second Division of the Fifth Nerve (superior maxillary). The diagram shows the nerve supply of the antrum and the palate. (Quain.)

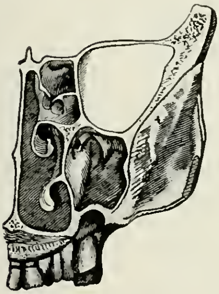

FIG. 153.

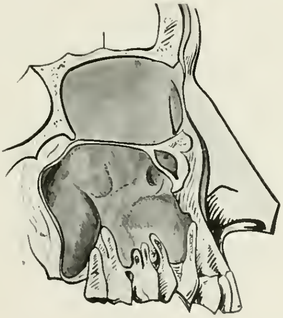

FIG. 154.

FIG. 153.—Transverse Section of the Skull, Showing the Anterior Half of the Antrum (as seen from behind). The rib seen on the posterior surface of the anterior wall is caused by the downward projection of the superior maxillary nerve. In the upper part of the inner wall the ostium can be recognized, and below this the swelling made by the lachrymal duct stands out prominently. The drawing shows also how an instrument passed upward and inward through the ostium of the antrum enters the ethmoidal labyrinth. (Original.)

FIG. 154.—A Drawing to Show the Fossæ Made in the Floor of the Antrum by the Upward Projection of the Tooth Roots. The deepest part of the antrum is behind the molar teeth. (Sieur and Jacob.)

NARROWING OF THE ANTRUM.—The antrum may be diminished in size by arrest in development, by retraction of the canine fossa, or by outward enlargement of the inferior or the middle meatus. (Fig. 155.) The whole antral wall may bulge outward or the enlargement may be confined to either meatus. (Fig. 156.) Where the antral wall, under the inferior turbinate, bulges outward, the roots of the teeth may appear in the nose. A hint as to the size of the antrum can be gained by placing the end of the forefinger in the canine fossa. If this is found to be deep the antrum is small.

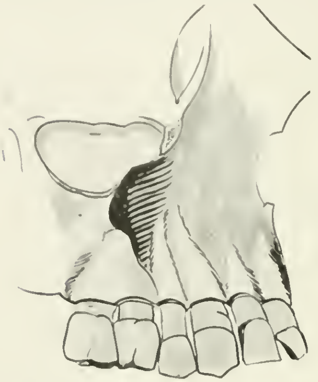

Fig. 155.—Narrowing of the Antrum by Retraction of the Anterior Wall Caused by a Deep Canine Fossa. (Sieur and Jacob.)

Enlargement of the Antrum.—The antrum is often increased in size by the fact that prolongations extend from it in different directions.

1. *The Orbital Prolongation.* (Fig. 157.)—A prolongation often rises from the main cavity of the antrum into the base of the ascending process of the superior maxilla. This is called the orbital prolongation. When it is large the crescent of light obtained on transilluminating the antrum is increased in size.

2. *The Malar Prolongation.*—The malar prolongation is a prolongation of the apex of the sinus into the malar process of the superior maxilla.

3. *The Alveolar Prolongation.*—When the floor of the antrum sinks below the level of the nasal cavity more than a quarter of an inch, the increase is called an alveolar prolongation.

4. *The Inferior Palatine Prolongation.* (Fig. 158.)—From the floor of the antrum a prolongation may extend toward the middle line in the substance of the hard palate. Through a prolongation of this kind pus from the antrum has been known to discharge into the roof of the mouth.

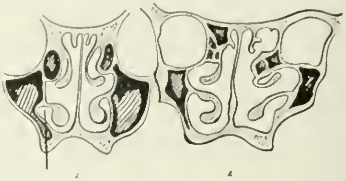

Fig. 156. Two Specimens of the Antrum. (Hajek.) 1. In this specimen the antrum is narrowed by the bulging outward of the outer wall of the nasal fossa below the inferior turbinate. In cases of this kind the roots of the teeth may at times be seen projecting upward into the floor of the nose. 2. In this specimen the antrum is narrowed by the bulging outward of the outer wall of the nose above the inferior turbinate.

5. *The Superior Palatine Prolongation.* (Fig. 159.)—The posterior upper inner angle of the antrum may be extended toward the sphenoidal sinus. This prolongation may reach the front wall of the sinus. In such cases the thin partition between the antrum and the sphenoid could readily be broken down by the necrosing action of pus.

The Nerves of the Antrum.—The infra-orbital nerve runs in the roof of the antrum, and its branches, the dental nerves, run inside the antrum on the different walls, reaching in this way the teeth. Branches of Meckel's ganglion come to the antrum from the spheno-maxillary fossa. There is a very rich connection between the nerves of the antrum and the nerves of the orbit. A branch nerve runs to the optic nerve, another to the lenticular ganglion, and a third to the external rectus muscle. A branch connects with the inferior maxillary nerve. The lachrymal nerve, the nerve of the eyelids and of the lachrymal sac, has a branch running to it from the antrum. A further branch connects with the facial nerve and helps to supply the orbicularis muscle of the lids. These numerous anastomoses show how readily disease of the antrum can affect the eye.

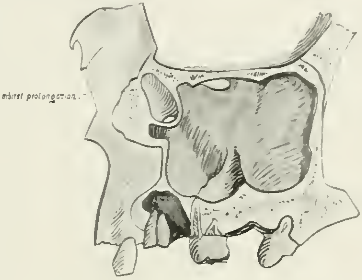

FIG. 157.—Orbital Prolongation of the Antrum. (Sieur and Jacob.) The prolongation in this case is nearly shut off from the rest of the antrum and communicates with it by a small oval opening at the bottom. The drawing shows two small transverse partitions in the floor of the antrum. This is the place where partial partitions commonly occur.

THE ARTERIES.—The arteries of the antrum are the spheno-palatine, the infra-orbital, and the facial.

THE VEINS.—The veins of the antrum drain posteriorly through the back wall into the spheno-maxillary fossa. Anteriorly they drain through the front face into the facial vein. Through the facial vein the venous blood reaches the cavernous sinus.

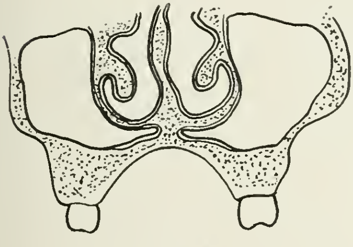

FIG. 158.

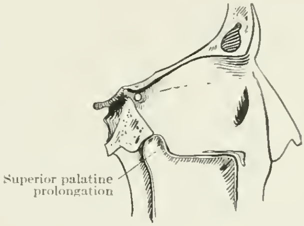

FIG. 159.

FIG. 158.—Inferior Palatine Prolongation of the Antrum. (Hajek.)

FIG. 159.—The Drawing Shows a Prolongation of the Antrum at Its Posterior Superior Internal Angle. This prolongation may extend to the front face of the sphenoidal sinus. (Sieur and Jacob.)

THE LYMPHATICS.—The lymphatics of the antrum are connected with the intracranial lymphatics. The chief trunks, however, empty into the large lymph nodes placed on the front of the body of the axis in the upper part of the pharynx. Still other lymphatic trunks join the nodes in the submaxillary region and the hyoid lymph nodes.

THE MUCOUS MEMBRANE.—The mucous membrane is composed of the usual three layers. The first is ciliated columnar epithelium, the second layer is the submucous, and the third and innermost is the periosteal layer. The mucous membrane readily becomes œdematous and polypoid.

ACCESSORY OSTIA.—The tail of the unciform process of the ethmoid, which stiffens the membranous area of the inner wall of the antrum, has a number of branches. Between any of these the mucous membrane may fail to develop and thus give rise to an additional opening into the antrum. In this way an accessory ostium is formed. An accessory ostium is not strictly pathological and is quite common. It is found in fully ten per cent of cases.

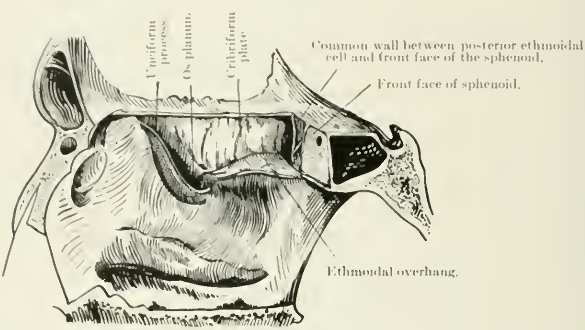

FIG. 160.—Drawing to Show How the Floor of the Ethmoidal Labyrinth Overhangs the Antrum. (Original.)

THE ETHMOIDAL OVERHANG.—From the ostium backward the lower side of the ethmoidal pyramid overhangs the antrum along the inner edge of the upper wall. (Fig. 160.) This overhang may amount to a full quarter of an inch. (Figs. 161 and 162.)

Pathology.—ACUTE INFLAMMATION OF THE ANTRUM.—Acute inflammation of the antrum generally occurs as a direct extension of an acute coryza or as an outcome of influenza. Occasionally it follows one of the exanthemata or pneumonia. It may be caused also by any of the acute or chronic processes which are common about the teeth. At times osteomyelitis of the alveolus, from tertiary syphilis, produces an acute infection of the antrum. Foreign bodies in the antrum and packing of the nose after nasal operations are also occasional causes of acute trouble.

At autopsy it is rare to find disease of the antrum due to the teeth. Zuckerkandl found, in 300 autopsies, only 1 case; Fraenkel found 2 in 146 autopsies. Clinically, the connection can be proved to exist in a larger proportion of cases.

Thus Gruenwald, out of 98 cases which came under his observation, found 14 in which the antrum disease was due to the teeth; Hajek, 13 out of 200.

Symptoms.—There is pain over the affected antrum, and this pain radiates to the forehead and to the temple. It may also be localized about the teeth or in the depth of the orbit. Sometimes there is an œdematous swelling of the cheek or of the eyelids. The eye weeps and is sensitive to light. The nose is more or less blocked, and the sense of smell diminished or abolished. A purulent or bloody secretion is found in the middle meatus and on the floor of the nose. In acute cases it seldom has a bad odor except in those in which the antrum disease originates in the teeth. The discharge may flow continuously or it may come in outbursts, with great relief of the symptoms.

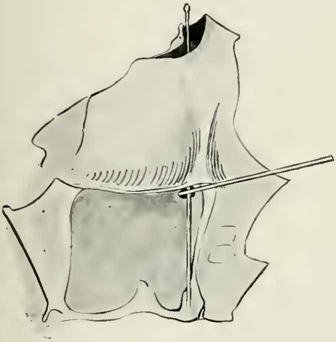

FIG. 161.

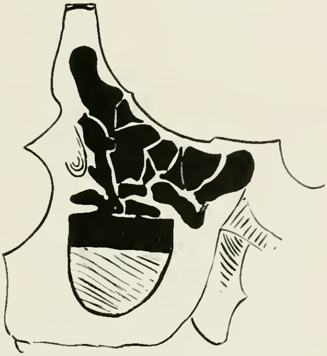

FIG. 162.

FIG. 161.—Straight Probe Passed from the Frontal Sinus through the Naso-frontal Duct and into the Antrum by the Ostium. This can be done in fifty per cent of the cases. The experiment shows that the antrum is the natural reservoir for the frontal sinus. (Sieur and Jacob.)

FIG. 162.—Paraffin Cast of the Accessory Sinuses and the Ethmoid Cells, Showing How the Antrum is a Natural Reservoir for the Frontal Sinus and the Anterior Ethmoidal Cells. (Sieur and Jacob.)

Usually the general symptoms are slight. There may, however, be chills and fever, with the ordinary symptoms which accompany these.

Diagnosis.—Where the symptoms are of a typical character, such as those just given, the diagnosis is easy. Transillumination shows the affected antrum to be dark. The x-ray furnishes much more valuable information than does transillumination. It shows whether the antrum is diseased alone or whether the frontal sinus and the ethmoidal region are involved as well; it also gives the relation of the tooth roots to the antrum. The diagnosis of disease of the antrum can be made positive only by washing pus from this sinus, either through the ostium or through an opening made by puncturing into it from the inferior meatus.

Treatment.—In mild cases the middle meatus should be kept dilated by the use of adrenalin oil, and the nose cleaned periodically with some alkaline wash. In severer cases the cavity of the antrum should be washed out, preferably by a catheter introduced into the sinus under the inferior turbinate. A solution of argyrol (twenty-five per cent to fifty per cent) can be used if the symptoms do not clear up readily. The condition of the teeth should be ascertained at the very beginning. If the teeth are involved the dentist should be urged to take radical measures with them, sparing neither bridgework nor crowns.

Prognosis.—Most cases of acute infection of the antrum speedily get well. The time varies from three to six weeks. Simple operative measures are sufficient. Rarely is it necessary to do more than to remove the anterior end of the middle turbinate and to establish a drainage opening into the inferior meatus. One or two thorough washings of the antrum may be all the treatment that is required.

Complications.—There have been reported cases of acute disease of the antrum in which there were severe eye complications, such as exophthalmos from swelling of the orbital tissues back of the globe, temporary amblyopia from pressure upon the optic nerve and the central artery of the retina, and finally orbital abscess. In the majority of these severe cases the teeth were the starting-point.

DENTIGEROUS CYSTS.—Dentigerous cysts are cysts which form about the anterior tooth roots. They are painless and lead to a swelling in the canine fossa which finally obliterates it. In long-standing cases there is a swelling in the roof of the mouth. An *x*-ray plate shows that the cavity of the antrum may be invaded and, in some cases, almost replaced by the cyst. The anterior wall of the cyst crackles under the finger. This wall may break down and the mucoid contents of the cyst be discharged. Examined at such a time the cavity of the cyst is found to be connected with a tooth root. The cavity usually becomes infected and from this time on discharges pus.

Treatment.—The front wall of the dentigerous cyst should be broken down and the cavity packed until it becomes obliterated. The walls of the cyst undergo involution as the process of granulation proceeds. The size of the cyst and the progress of the involution can be followed by packing the cavity at intervals with gauze impregnated with subnitrate of bismuth, and by taking an *x*-ray plate of the region. (See also page 196.)

FOREIGN BODIES IN THE ANTRUM.—Foreign bodies in the antrum are not a very rare cause of chronic suppuration. The commonest foreign bodies are particles of vomitus and fillings from the teeth.

Treatment.—The relief of such cases by treatment is very striking. A good-sized cannula is introduced into the sinus through an opening made under the inferior turbinate, and the cavity is forcibly washed by means of a powerful syringe. A single forcible washing is often sufficient to clean the antrum and to prevent the re-formation of pus. After a forcible irrigation it is not always possible to determine the nature of the foreign body from the inspection of the water used in the injection, but it seems that a foreign body of some kind must have been present, from the fact that forcible washing is required to clear up a case of this character. Gentle irrigation will not accomplish it.

Mucocele of the Antrum.—Mucocele of the antrum is rare. As in the case of the other sinuses, mucocele of the antrum leads to painless dilatation of the antrum. This shows itself by an inward bulging of the membranous area of the inner wall and by a thinning and outward bulging of the anterior wall. In dentigerous cysts the anterior wall of the antrum likewise becomes thin and is pushed forward. The cavity of the antrum is invaded also. Such cases might easily pass for cases of mucocele of the antrum. It is probable that in the majority of the so-called cases of mucocele of the antrum there were merely cysts of the antrum.

Chronic Inflammation of the Antrum.—Acute inflammation of the antrum, in all cases in which the teeth are the cause of the infection, is liable to turn into chronic inflammation. Examinations by means of the *x*-ray are constantly showing that in many cases the disease is due to infection from the frontal sinus or from the ethmoidal cells.

Symptoms.—Some patients seem to be so tolerant that chronic disease of the antrum is discovered only by the routine examination of the nose. In most cases, however, there is pain over the brow or in the temple. There may be pain over the antrum itself and tenderness on pressure in the canine fossa. The teeth may feel as if they were too long or they may ache. Often the patient is conscious of a bad smell and a bad taste. The odor is perceptible to the examiner. When such an antrum is washed out the foul odor is marked. A temporary œdema of the cheek or of the eyelids may occur. The chief complaint of many patients is intense neuralgia of the trifacial nerve. The symptoms increase in severity as the antrum fills up and during the exacerbations of the inflammation.

In cases without exudate, as well as in cases where the secretion is only serous, the typical symptoms fail. The case of Noltenius, where the patient complained only of excessive flow of water from the nose, comes under the head of chronic disease of the antrum with atypical symptoms. In chronic disease of the antrum, therefore, most of the symptoms are due to the presence of pus in that cavity.

The classical symptoms of chronic suppuration in the antrum are: Pus in the nose; thinning of the walls of the antrum to such an extent that the finger placed in the canine fossa feels the anterior wall crackle beneath its pressure; swelling of the cheek from infection of the soft parts; increase in the flow of pus when the patient bends his head strongly forward and toward the well side; and infra-orbital neuralgia. One or more of these symptoms are generally present, but seldom all of them.

Diagnosis.—If a patient complains that, on bending the head forward, pus or bloody fluid runs out of the nose, and, further, if he states that he notices a bad odor, the diagnosis of disease of the antrum can be made with considerable confidence. There may be, in addition, tenderness at the base of the ascending process of the superior maxilla, but disease of the ethmoidal cells gives the same sign. Of all the sinuses the antrum should be suspected first, and when, as the result of an examination, it is found that the sinus is apparently normal, we should not yield too easily to this belief, but should, if the symptoms persist, institute a further and more careful examination. Puncture of the antrum is the surest method of making a diagnosis of disease of this sinus. Whenever the patient complains of a bad odor, puncture of the antrum should be a routine practice.

Upon direct examination pus is seen in the middle meatus, on the inferior turbinate, and on the floor of the nose. Posterior rhinoscopy shows pus on the posterior end of the inferior turbinate. Fraenkel's test for detecting pus in the antrum is made in the following manner: The nose is first thoroughly cleaned. Then the head is bent strongly forward and turned to one side, so that the diseased antrum is uppermost. After a short time, if the antrum is diseased, pus drops or flows from the nose; or, if it does not actually flow from the nose, it may be found in the middle meatus by placing the patient again in an upright position. Absolute proof of the presence of pus in the antrum is obtained when we actually see it flow along a probe that has been introduced into the sinus, or from the free end of a catheter that has similarly been introduced, or in the water that escapes from the sinus when it is irrigated.

Catheterizing the Antrum.—The drainage opening of the antrum lies in the unciform groove in the outer wall of the lower anterior part of the middle meatus. It is an inch and a half from the posterior edge of the alar cartilage. In order to catheterize the sinus a small Eustachian catheter is bent at a right angle at a point a little less than half an inch from the tip. The instrument is introduced to the outside of the middle turbinate in the lower anterior part of the middle meatus, and the point is turned outward against the membranous wall of the antrum in the region of the ostium. When the middle meatus is roomy the point of the catheter, when moved forward and backward, will in many cases fall into the ostium. But if the opening is not readily found, the catheter can be forced through the membranous area by pressure. This is somewhat painful, but often it is the only way by which access to the antrum may be gained. If force must be used it is better, under the circumstances, to employ a catheter which has a cutting point. Very often the middle meatus is so narrow that the surgeon cannot manipulate the catheter freely enough to find the ostium. In such cases the anterior end of the middle turbinate should be removed.

Treatment of Chronic Suppuration of the Antrum.—Before treatment of chronic suppuration in the antrum is undertaken, the *x*-ray plate should determine the condition of both the ethmoidal labyrinth and the frontal sinus, and it should also show whether or not tooth roots project into the antrum, or whether there is a foreign body in the cavity. It is useless to treat an antrum which is acting as a reservoir for the frontal sinus unless we first deal with the sinus above.

Removal of the Anterior End of the Middle Turbinate.—The first step in the treatment of chronic suppuration of the antrum is to clear the middle meatus, so that the antrum will drain freely. To accomplish this, all polypi are removed, and also the anterior half or all of the middle turbinate as well.

But little can be accomplished by treating chronic disease of the antrum through the middle meatus, even if the ostium is enlarged by the removal of the membranous area which adjoins it. The opening is too high for efficient drainage.

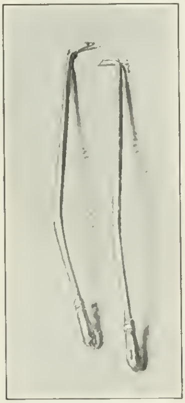

FIG. 163.—Sharp-pointed Cannulæ (right and left) for Entering the Antrum through the Membranous Area of the Middle Meatus.

The Routes by which the Antrum Can be Entered.—*a.* Route through the Middle Meatus.—The probe is entered in the middle meatus in the manner described above in the paragraph relating to catheterization of the sinus. If the antrum is full and the membranous area is bulging into the meatus, the probe at once breaks its way into the antrum and there is a gush of pus. If this does not happen, the point of the probe is moved forward and backward and then upward and downward until the ostium of the antrum is found. If this is not found readily, a little force will often send the probe into the antrum. Rather than search a long time for the ostium it is better to use a sharp-edged cannula and to cut an opening through the membranous area at once. A wide opening can be torn in the membranous area by using Hajek's hook. (Fig. 163.)

b. Entering the Antrum through the Inferior Meatus.—The antral wall along the attachment of the inferior turbinate is very thin, and advantage is taken of this fact for both exploratory and therapeutic purposes. The technique of making an opening in the wall of the antrum at this point is as follows:—The lower part of the inferior meatus, between the inferior turbinate and the wall of the antrum, should be well cocainized. A spot is chosen half-way back on the inferior turbinate, and at this point, high up between the turbinate and the outer wall of the nose, as near the attachment of the turbinate as possible, a curved trocar and its cannula are forced upward and outward into the antrum. (Fig. 164.) The wall of the antrum is so thin, at this point, that the trocar should enter the antrum easily and without causing much pain. In a very small percentage of cases (three per cent or four per cent) the walls of the antrum are thick from the presence of a rudimentary antrum. In such rare cases this procedure would be difficult or would fail entirely.

c. Entering the Antrum through the Canine Fossa.—After the mucous membrane in the canine fossa has been cocainized a straight trocar and cannula are driven with a few taps of the mallet into the antrum. Often the trocar can be pushed through the anterior wall.

d. Entering the Antrum through the Alveolar Process. If the first or the second molar tooth has been lost, the antrum can be entered by drilling into it through the alveolar process from the bottom of the tooth socket. This can be done either with a hand drill or with the ordinary motor-driven drill. After the antrum is entered, the cavity is washed out with sterile water. Often forcible washing is necessary, because the pus is thick and lies in heavy masses at the bottom of the antrum. For this reason, washing the antrum through the ostium is unsatisfactory. When the injected water returns clean, the antrum is dried by sending a stream of air through it until all bubbling ceases.

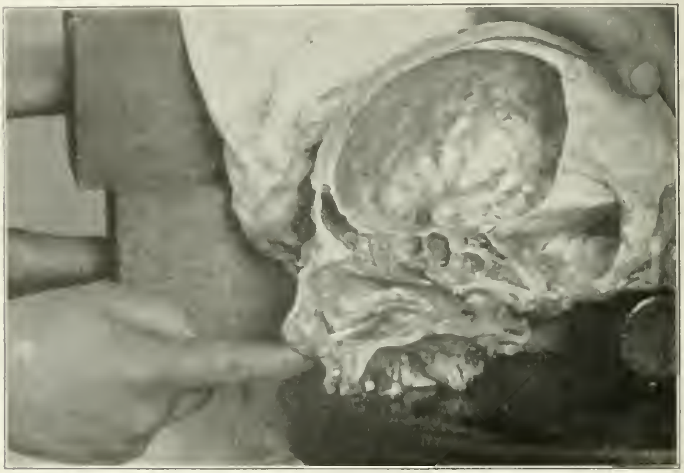

Fig. 164.—Puncturing the Antrum from the Inferior Meatus. (Original.) For the sake of clearness the whole length of the inferior turbinate has been removed nearly to its attachment. The point of the instrument is placed at the middle of the turbinate, close under its attachment. This is the best place for puncturing the antrum from the inferior meatus.

Theoretically, draining the antrum through the alveolar process should be the best method of all, since the cavity is here entered at its lowest point. It would be a good method if the opening established could be kept patent, without the wearing in it of a cannula or a plug. The cannula acts as a foreign body, keeps up the discharge, and finally causes necrosis of the alveolus about it. The antrum can be entered easily through the tooth sockets of the first or second molar tooth. The lowest point in the floor of the antrum is back of these teeth. Unless the alveolus is atrophied, the average thickness over the molar teeth is half an inch. The method of treating chronic suppuration of the antrum by a cannula inserted into it through the alveolus has long been popular with dentists. Stormy surgical symptoms are readily relieved and the discharge lessened, but a cure is seldom effected. Rhinologists are still receiving cases which have been treated by the alveolar route and are wearing a cannula. In treating these cases it is absolutely essential to remove the cannula at once, to curette out the dead bone round it, and to sacrifice the teeth which border on the opening if there is the slightest suspicion that they have become diseased by the long presence of the cannula. It often is necessary to make a large opening in the alveolus before sound bone is reached. This opening can be temporarily closed by the application of a plate. The wearing of such a plate does not prevent the ultimate healing of an opening the diameter of which may measure as much as half an inch. One is tempted to use the alveolar route because the patient can so easily wash out the antrum himself. Nevertheless, except as a temporary procedure in acute cases, this route should not be used.

The antrum can be reached, as has just been described, by several routes. Only two of these, however, give good results in treating chronic suppuration. These two routes are: the intranasal route by way of the inferior meatus, and the route through the canine fossa. The latter is the more surgical inasmuch as it allows a thorough inspection of the diseased conditions within the antrum and permits direct treatment. At the present time, however, with our improved technique, the intranasal operation is steadily increasing its percentage of cures, and consequently operators are taking it up with enthusiasm.

Technique of the Intranasal Operation.—Both the middle and the inferior meatus are well cocainized, and both turbinates are shrunk with adrenalin. The wall of the antrum, to the outside of the inferior turbinate and below its attachment, is anæsthetized by swabbing with the cocaine solution. The anæsthesia of the antral wall should be as complete as possible, because the greater part of the operative procedure is carried out at this point. The patient is placed in a chair in a sitting posture, and his head is thrown upward and backward against a head-rest. The operator does most of his work standing. The middle turbinate, or at least the anterior half, is removed as the first step in the operation. (Figs. 77 and 78.) At a point opposite the middle of the inferior turbinate, well up near the attachment of the turbinate, in the groove between the turbinate and the lower part of the antral wall, a trocar chisel is placed and the point turned upward and outward, as if one were aiming at the external canthus of the eye. With a blow of the mallet the chisel is driven through the thin wall into the cavity of the antrum. (Fig. 166.) The chisel is withdrawn, a long-handled mastoid curette is placed in the opening in the wall of the antrum, and the opening is enlarged by prying inward. By rapidly repeating this procedure three or four times and by gradually working backward, parallel with the attachment of the inferior turbinate, a large opening can be made in the lower part of the antral wall. At this stage in the operation the antrum is syringed free from pus. The operator now sits down and under direct illumination trims away the mucous membrane about the bone opening with a small conchotome. This should be accomplished as thoroughly as possible, because the mucous membrane tends to reproduce itself around the opening and narrow it. In order that the opening may be as free as it can be made, it is well to remove, at this time or soon afterward, the anterior half of the inferior turbinate. Unless this is done, much of the work has to be carried out by aid of the sense of touch.

The inferior and the middle meatus may be lightly packed, or not, according to the preference of the operator. Unless the patient can be kept quiet in the hospital for at least one day, I should introduce packing and allow it to remain undisturbed for a few hours. If no packing is used, the patient should be cautioned not to blow his nose. Some operators blow into the middle meatus powdered suprarenal capsule and dispense with packing the nose.

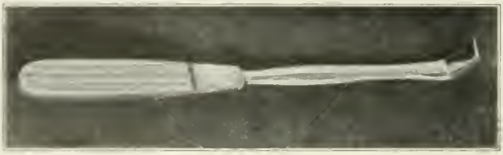

Fig. [illegible].—Wood-handled Right-angled Retractor for Exposing the Canine Fossa.

The after-treatment consists in the daily washing of the antrum with normal salt solution or with a weak solution of corrosive sublimate. Many patients, if given a proper cannula, can be taught to wash out the antrum themselves. As the discharge lessens, the antrum is syringed with a solution of argyrol (twenty-five per cent or fifty per cent). This helps to clear up the crusting which occurs about the cut end of the inferior turbinate and the stump of the middle turbinate. When this method succeeds a cure is obtained within a period varying from six weeks to six months. The patient can wash out his antrum by using a nasal douche in the following manner: The head is held forward with the diseased antrum below the other, and the stream from the douche is passed through the nostril of the well side and out through the other. As a preliminary step the nostrils should be given as large a calibre as possible by the use of adrenalin, so that there will be an easy flow and consequently less danger of the fluid entering the ears, by way of the Eustachian tubes. The patient should also be cautioned about blowing the nose. Where a large opening is maintained in the wall of the antrum, this method of washing out the cavity is very satisfactory.

The aim of the operation is to get a large permanent opening in the lower part of the inner wall of the antrum to the outside of the inferior turbinate. For making this the operator has a large choice of instruments. These fall into three varieties: chisels and trocars, burrs, and conchotomes. The burr and the conchotome make the cleanest opening. With these instruments it is easy to make an opening nearly the whole length of the inferior turbinate. The height of the opening is limited above by the attachment of the turbinate. Many operators use this method first and save the canine-fossa operation for the cases in which it fails to cure.

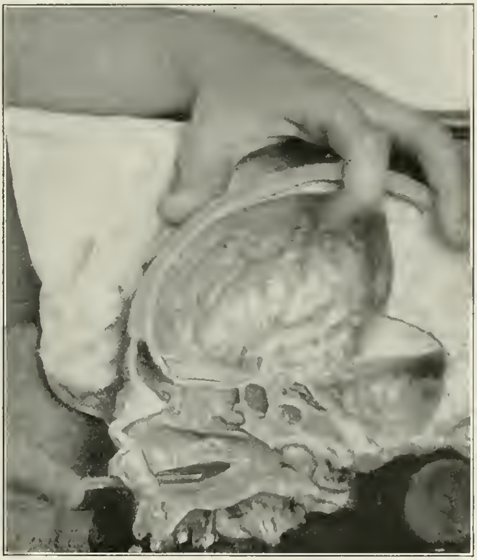

FIG. 166.—Breaking an Opening with the Curette into the Antrum from the Inferior Meatus. The opening (about one-fourth inch high and three-fourths inch long) extends upward to the attachment of the inferior turbinate. The latter has been removed in order to show the site of the opening into the antrum. (Original.)

Technique of the Operation by Way of the Canine Fossa.—By opening the antrum through the canine fossa it is possible to determine the nature and the extent of the pathological processes within this cavity. For this reason I prefer this operation for the majority of cases of chronic suppuration in the antrum. The operation has been done under cocaine. Unless such a course is contraindicated, ether narcosis is preferable, because it permits more thorough work. The patient is placed in the half-sitting position, and the choana and the nasal cavity on the side of the diseased antrum are tamponed from the front. The canine fossa is thoroughly exposed by retracting the cheek forward and upward by means of two long and narrow right-angled retractors. (Figs. 165 and 168.) A strip of gauze, about an inch and a half wide and two feet in length, is packed bit by bit between the cheek and the upper teeth opposite

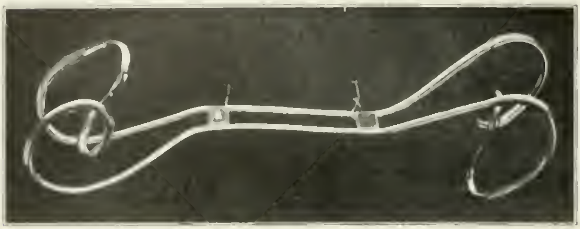

Fig. 167.—Author's Cheek and Lip Retractor, for Exposing the Canine Fossa. One end is for the right side, the other is for the left.

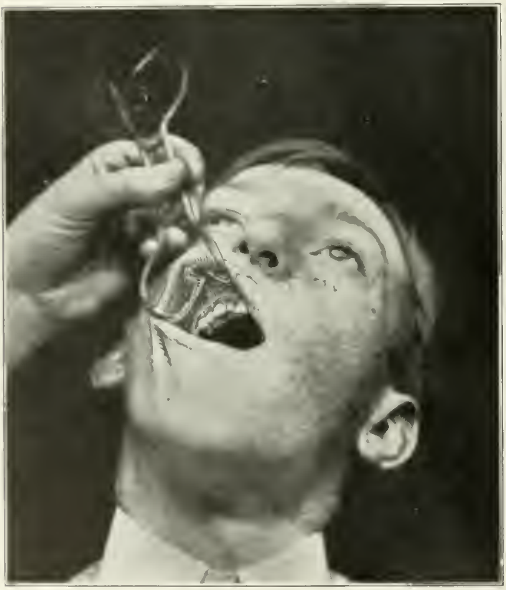

Fig. 168.—Method of Using the Author's Cheek and Lip Retractor in order to Expose the Canine Fossa, for Operating Purposes or for Examining the Teeth.

the molars, and then the gauze strip is brought down and packed between the cheek and the lower teeth until the lower half of the buccal fossa is obliterated. The gauze serves to catch the blood which flows from the antrum and keeps it from getting into the pharynx. This packing is changed when the gauze is saturated. A horizontal incision is made a quarter of an inch above the margin of the gum. The incision cuts through the frenum of the upper lip and runs round to the anterior edge of the tuberosity. Without a generous incision of this kind it is hard to retract the mucous membrane so as to expose the canine fossa completely. The incision is carried to the bone, and then the soft tissues are stripped upward until the front wall of the antrum is fully exposed. A chisel is placed in the canine fossa some distance behind the canine tooth, and driven into the antrum. The whole front wall of the antrum is then cut away with a right-angled punch or with a conchotome. The opening should be made large enough for the forefinger to be introduced through it easily. In order to secure such an opening the bone incision must run well backward and even encroach a little on the posterior wall. If the bone opening is carried upward to the orbital rim the infra-orbital artery is in danger of being injured. When it is wounded it gives annoying bleeding. The lower internal angle of the front face of the antrum should be removed flush with its line of junction with the inner wall of the antrum—that is, up to the nasal notch. (Fig. 169.) This is done in order that, if the operator wishes to pass an instrument from the antrum into the ethmoidal labyrinth, this instrument may be held as nearly parallel to the septum as possible. The antrum once fully opened, its cavity is explored with the forefinger or the little finger for partial partitions and for projecting tooth roots. It is impossible, in most cases, to distinguish between normal and diseased mucous membrane; consequently the whole of the mucous membrane, and with it all polypi, should be curetted out. All corners, and especially the

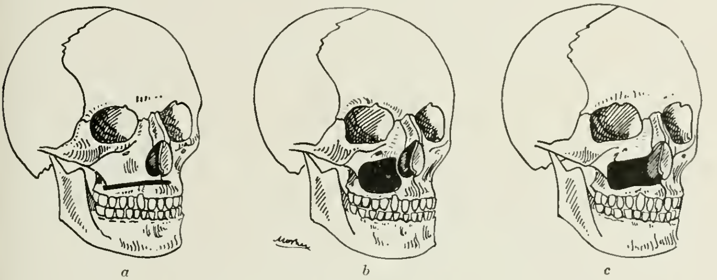

Fig. 169.—Diagrams Illustrating Various Operative Procedures on the Antrum. (Original.)

a. Line of the incision through the mucous membrane in the radical antrum operation by the canine-fossa route. It is essential that the incision be made fully as long as that shown in the figure.

b. Bone opening in the canine fossa. This is carried to the nasal notch, but not through it.

c. Bone opening in the canine fossa carried through the nasal notch into the nose. By taking away the rim of the nasal notch the antral opening in the nose is brought so far forward that the after-treatment of the antrum through the nose is made much easier.

pockets in the uneven floor, should be carefully explored and cleaned. If a small post-nasal mirror is placed in the antrum it will detect any islands of mucous membrane which have been left. The cavity of the antrum bleeds freely, so that rapid and repeated sponging is necessary. In order to control the bleeding it is useful to obliterate a part of the cavity with gauze and to work in front of the packing until it becomes necessary to operate in the part thus tamponed off. When the antrum is freed of mucous membrane and polypi a small chisel is placed against the lower part of the inner wall and driven through it into the nose. The opening is made large enough to permit the use of a right-angled punch, and then, with this instrument, a finger-like opening is made through the whole length of the base of the inner wall. The attachment of the inferior turbinate constitutes the upper rim of the opening. As the bottom of the antrum is always lower than the floor of the nose, it is important that none of the inner wall of the antrum should be left as a ridge between the two. A chisel is useful in smoothing off the base of the inner wall. When the edges of the opening from the antrum into the inferior meatus are freed from bits of loose bone and tags of mucous membrane, the anterior half of the inferior turbinate is pulled into the antrum with a pair of double hooks and cut off with scissors. The antrum is now packed with gauze or with a strip of gauze wrapped with Cargile membrane. In cases where the mucous membrane of the antrum is not found to be markedly diseased, some operators do not curette it out. When the mucous membrane is not removed, the antrum is not packed.

One or two stitches are taken in the oral mucous membrane along the line of the incision. If tent packing is used, the body of the packing is removed on the second day, and the covering on the third or fourth; if strip packing is used, it is taken out on the second day. The packing once out, it is not replaced, but the incision is allowed to close. A fistula rarely remains unless the antrum is washed out through the canine fossa for a considerable period of time. For the first two or three days the antrum is washed out by this route, but not afterward. Further washing is done through the nose. After this operation, if packing is used, the cheek over the antrum swells and remains swollen for about a week. The skin of the cheek feels numb for about three months.

The after-treatment consists in washing the antrum through the opening in the inferior meatus, and in keeping the mucous membrane from forming a diaphragm over the opening and narrowing or closing it. After a few months the operator will be surprised to see how much narrowing takes place in spite of all his efforts. If the opening becomes too small for proper drainage it can be readily enlarged from the nose. The time which must elapse before this operation results in a cure varies from six weeks to six months. Everything considered, this is the most satisfactory operation for chronic suppuration in the antrum.

The stump of the inferior turbinate forms crusts for some weeks. These are best controlled by the use of solutions of argyrol. For exposing the canine fossa in order to remove the antral packing, or for inserting a cannula into the antrum, the author's cheek retractor (Fig. 167) is of service. If a fistula persists in the canine fossa it can be closed easily by paring its edges and putting in a suture or two. If the anterior end of the inferior turbinate cannot be removed by way of the antrum, the packing should be removed from the nose and the turbinate removed intra-nasally. Occasionally it is awkward to do this under ether, and therefore it is better to remove it later, under cocaine.

Variations of the Operation through the Canine Fossa.—If the posterior ethmoidal cells are diseased and the operator wishes to reach them by the antrum route, the upper part of the inner wall of the antrum—that is, the membranous area—should be broken down and then removed with the conchotome. In uncomplicated cases of chronic suppuration of the antrum the removal of the upper part of the inner wall makes a second opening through which drainage is possible. If time permits, it is well to make such an opening.

Attempts are made by some operators to save the mucous membrane of the inner wall of the antrum and to turn it inward to serve as a flap to cover part of the denuded antrum. Unless the whole of the mucous membrane of the inner wall is saved and turned outward, inferior turbinate and all, as indeed one surgeon does, it would hardly seem to be worth while. Saving flaps of mucous membrane in various nasal operations has not, as a rule, proved worth the doing. I have not seen the nutrition of the teeth interfered with after the radical antrum operation.

Wounds of the Antrum.—Punctured wounds of the antrum usually occur through the front wall in connection with a similar wound of the cheek. The treatment of such a condition would be the ordinary surgical cleansing of the flesh wound and washing out the cavity of the antrum through the wound in the front wall if it is of sufficient size to permit it. If it is not, the antrum should be watched for signs of sepsis. If these set in, the antrum should be entered through the inferior meatus and irrigated. If prolonged suppuration follows, the antrum should be entered through the canine fossa and explored for bits of dead bone.

In depressed fracture of the malar bone the front wall of the antrum is crushed in. In treating this condition the malar bone and the front wall of the antrum are raised into position by exposing the canine fossa and making an opening into the antrum through the front wall large enough to admit a stout, curved curette. With this the malar bone and the front wall of the antrum are pried into place. If the bones retain their position after their readjustment, nothing further is needed except to protect the parts from further trauma. If, however, the bones do not stay in place, they may be made to do so by packing the antrum for a few days with gauze.

Malignant Disease of the Antrum.—Carcinoma of the antrum is fairly frequent. Sarcoma is not so common as carcinoma, but still it is not rare. The chief symptom of malignant disease of the antrum is pain. Later, there is the cachexia which goes with malignant disease, and, when the tumor has outgrown the antrum, a swelling appears in the canine fossa or in the nasal cavity. The part of the growth which projects into the nose bleeds easily. There is a discharge of blood or pus from the nostril of the affected side. It is extremely unfortunate that the diagnosis of malignant disease of the antrum is so seldom made until the growth has exceeded the limits of the antrum and has rendered its thorough removal impossible. In a person of middle age, an offensive nasal discharge, whether accompanied by pain or not, should have its cause immediately determined by a thorough examination of the nose and the accessory cavities.

Treatment.—As a first step, the antrum should be opened by way of the canine fossa, and the nature and the extent of the growth ascertained. The etherizing should be carried on by tubes passed through the nose into the pharynx. The use of the tubes makes it possible to pack the pharynx with gauze, thus removing the danger of blood getting into the trachea. No matter how extensive the operation may be, unless it is undertaken before the growth extends beyond the walls of the antrum it will be, in the majority of cases, simply a palliative procedure. (For further details regarding diseases of the antrum the reader is referred to the article on "Surgical Diseases of the Jaws," in the present volume.)

VI. THE APPLIED ANATOMY AND THE DISEASES OF THE SPHENOIDAL SINUS.

Anatomy.—The sphenoid bone consists of a body and two sets of wings. The body is quadrilateral and is hollowed by a cavity. This is divided, by a median partition, into two sphenoidal sinuses, a right and a left. One large venous sinus—the cavernous—and four small ones touch the sphenoid bone, and three chief arteries of the skull touch it or pass through foramina in it; six of the twelve cranial nerves are in relation with it; all the bones of the skull centre round it, and five of the bones of the face articulate with it; and it comes into relation with the cerebellum and the two basal lobes of the brain.

ABSENCE OF THE SINUS.—Absence of the sinus has been reported a few times. (Zuckerkandl and Hertzfeld, 1898.) I found it wanting once in one hundred heads.

SIZE.—The sinus is often larger on one side than on the other, with the difference generally in favor of the left. It may hold only a drop of water or may be large enough to hold 9 c.c. (2½ drachms). The average amount is 5–6 c.c. (1½ drachms).

Form.—In form the sinus is usually a cube, but the regularity of this is broken by the indentation in the superior wall caused by the sella turcica and by the pressing in of the cavernous sinus on the two sides.

The Cavity of the Sinus.—The sinuses are separated, the one from the other, by a median partition. Often this is not symmetrically placed, and hence one sinus may be much larger than the other. In such a case it is possible for the larger and predominating sinus to be in relation with the cavernous sinus on both sides, and for the same reason a left sinus may be the starting-point of disease in the right optic nerve. Occasionally the sinus has a double but incomplete partition. In young subjects the sinus does not extend back of the optic foramen, while in the normal adult it reaches the middle of the sella turcica. The average antero-posterior diameter varies from 1 to 2 cm., or from one-half to three-quarters of an inch.

The Development of the Sinus.—The sphenoidal sinus is formed by a prolongation of the nasal mucous membrane through a small triangular scale of bone, the remnant of the sixth turbinate of the fœtus. This bit of bone finally fuses with the front face of the body of the sphenoidal bone and becomes a part of the front wall of the sinus after the cavity has been formed. At birth the sphenoidal sinus has a well-formed ostium and a suggestion of a cavity. At two years of age the cavity is the size of a pea. From this time onward, the sinus grows more rapidly than is usually supposed. In a child of ten I have found the sinus to measure an inch from before backward. Three-quarters of an inch is given as the normal antero-posterior diameter of the adult sinus. This, I am confident, is too small.

The Mucous Membrane of the Sinus.—The mucous membrane of the sphenoidal sinus is a prolongation from the nasal mucous membrane. It is thin and very lightly attached. If there is a very large bony ostium it forms a diaphragm over it with an opening in the centre. There are the usual three layers—the mucous, the submucous, and the periosteal. The epithelium covering the membrane is ciliated, like that of the mucous membrane of the nose. Grouped about the ostium there are many glands. These occasionally degenerate into cysts. Many vessels run in the submucous layer, and at the optic foramen these communicate freely with the vessels of the orbit. The lateral walls of the sphenoidal sinus are cribriform, with minute foramina, through which vessels run from the sphenoidal sinus into the cavernous sinus. There is a venous connection also through the sella turcica and through the anterior face into the posterior ethmoidal cells. The arteries which supply the sinus are the spheno-palatine, the pterygo-palatine, and the Vidian—all branches of the internal maxillary artery in the spheno-maxillary fossa. A branch of the spheno-palatine artery crosses the face of the sinus and enters the ostium to supply the inside. The other two arteries lie on the under side of the body and run in bony canals.

Lymphatics.—The lymphatics join both the deep lymphatics of the neck and those at the base of the brain.

The Relations of the Different Faces of the Sinus.—*The Upper Face.*—The upper surface is intracranial. (Fig. 170.) From before backward it is made up, first, of a portion of the lesser wing. Then come the optic groove and the olivary eminence; and, next, the surface falls sharply in the sella turcica, to rise again into the posterior clinoid processes and the back of the saddle. In a large sinus this upper face comes into relation anteriorly with the posterior ethmoidal cells and posteriorly with the basilar groove. The length, in such cases, may be from 20 to 31 mm. (¾ to 1¼ inches). A small sinus does not extend back of the optic groove. The posterior ethmoidal cells may extend posteriorly and so lie above the superior face of the sinus.

In the adult this face is usually thin. In the young, on the other hand, it is thick—3-6 mm., or from ⅛ to ¼ of an inch. In a large sinus the roof is liable to be very thin. Zuckerkandl has reported the absence of this upper wall. Sieur and Jacob have not observed its absence, but have seen it so thin that the dura could not be removed without bringing this wall with it.

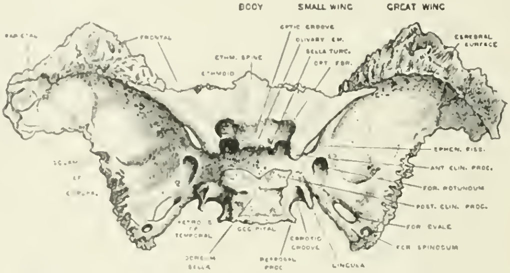

Fig. 170. The Sphenoidal Bone as Seen from Above. (Quain.)

The most important structure with which the upper face is related is the dura. In front there are the optic nerves and the ophthalmic arteries, imprisoned on either side in the optic canal. Behind these, on the thicker olivary eminence, is the optic chiasma. The fact that this is placed on thicker bone has been given as the reason why the optic nerves are so much oftener affected in sinus disease than the chiasma. Still farther back, in the cavity of the sella turcica, there is the pituitary gland. Tumors springing from this occasionally invade the sinus. The upper surface has a venous sinus in relation with it, viz., the coronary.

The External Face. (Fig. 171.)—From before backward the following structures are noticed: the optic canal, for the second time, the sphenoidal fissure, then the large cavernous sinus, and finally the internal carotid artery. Outside of the cavernous sinus there are: anteriorly, the foramen rotundum, carrying the superior maxillary nerve, and posteriorly the foramen ovale, carrying the inferior maxillary nerve.

The relationship of the external face of the sphenoidal sinus with the cavernous sinus is one of great importance. Within this there are the internal carotid artery, the motor nerves of the eye, and the first branch of the great fifth nerve. Both the ophthalmic and the internal carotid arteries occasionally project into the sinus. A small venous sinus, the inferior petrosal, is in relation with the external wall.

The external face, like the superior one, is fragile. Fractures of the base of the skull are liable to extend through this face, and readily open up the important blood channels which have just been mentioned. Disease involving this face of the sinus may cause progressive ocular troubles, violent pain, epileptiform attacks, crises of vomiting, meningitis, and finally brain abscess.

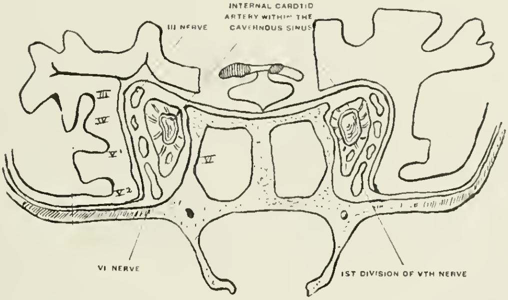
III NERVE
INTERNAL CAROTID ARTERY WITHIN THE CAVERNOUS SINUS
III
IV
V1
V2
VI
VI NERVE
1ST DIVISION OF VTH NERVE

Fig. 171.—Diagram Showing the Relation of the Outer Wall of the Sphenoidal Sinus to the Cavernous Sinus. The contents of the cavernous sinus—namely, the third nerve, the fourth nerve, the first division of the fifth nerve, the sixth nerve, and the internal carotid artery—are also shown. (Sieur and Jacob.)

The Posterior Face.—This face is intracranial. (Fig. 172.) It is hollowed out by the basilar groove, in which lie the basilar artery and the medulla oblongata and pons. Here, again, there is another venous sinus, the occipital. There are venous sinuses, therefore, on three sides of the body of the sphenoid—the superior, the external, and the posterior.

The Inferior Face.—The inferior face is in relation with the nose and the pharynx. Through a small foramen in this face runs the pterygo-palatine artery. The width of this surface varies from 20 to 25 mm. (¾ to 1 inch). It measures from 3 to 10 mm. (⅛ to ⅜ of an inch) in thickness and is therefore too thick to puncture easily. In two-thirds of the cases this face does not reach as far back as the pharynx. The mucous membrane over it varies from 3 to 4 mm. (⅛ inch) in thickness, and contains much fibrous tissue. The membrane becomes thinner as it turns up over the anterior face of the sphenoid. This locality is supplied by the pterygo-palatine and the Vidian arteries. The width of the right choana is 12 or 13 mm. (½ inch), that of the left 17 mm. (about ⅝ inch). In a large sinus the length of the inferior surface often is as much as 30 mm.

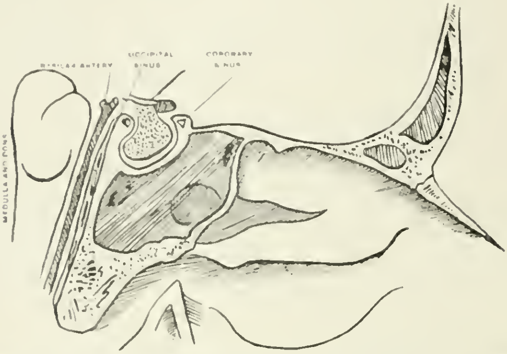

Fig. 172.—Diagram Showing a Large Sphenoidal Sinus which Extends to the Posterior Wall of the Body of the Bone. (Sieur and Jacob.)

(1¼ inches). Only in a very large sinus would an attempt to make an opening here be justifiable.

The middle lacerated foramen containing the internal carotid artery is in relation with the inferior surface. In a wide sinus the Vidian nerve lies in the floor, *i.e.*, in the substance of the inferior face. This is the motor nerve of Meckel's ganglion.

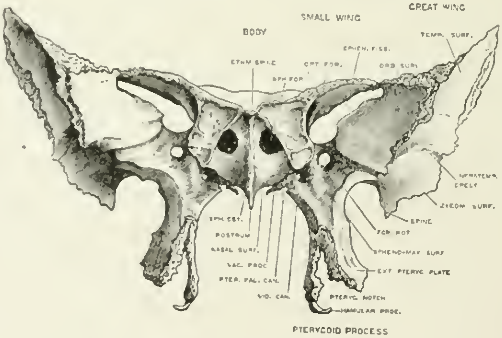

Fig. 173.—The Sphenoidal Bone as Seen from in Front. (Quain.)

The Anterior Face.—This face is divided into two parts: an outer, which abuts against the posterior ethmoidal cells, and an inner, which is free and forms the upper and back wall of the nasal cavity. (Fig. 173.) The septum of the nose is continued back to the middle of the free part of this face, and forms there a median partition. The transverse measurement of this face varies from 28 to 30 mm. ($1\frac{1}{4}$ inches). In a well-developed sinus this face makes a right angle with the cribriform plate, and averages in height from 16 to 18 mm. ($\frac{3}{4}$ inch).

The Ostium.—The drainage opening of the sinus is placed in the anterior face. (Fig. 173.) The ostium, as the opening is called, is situated nearer the upper than the lower border. Generally it is 4 mm. ($\frac{1}{5}$ inch) from the top, or between 8 and 10 mm. (about $\frac{1}{4}$ inch) from the bottom. The opening measures from 2 to 3 mm. ($\frac{1}{8}$ inch) vertically, and from 1 to 2 mm. ($\frac{1}{16}$ inch) transversely. In a majority of cases the opening cannot be seen unless the middle turbinate is first removed. The distance from the centre of the nasal opening varies from 5 to 8 cm. (2 to $3\frac{1}{7}$ inches), and from the nasal spine it is $6\frac{1}{2}$ or 7 cm. ($2\frac{1}{2}$ to $2\frac{3}{4}$ inches). The spine is hard to find, and the middle of the anterior nares is a variable point. I prefer, therefore, to measure from the lower border of the lateral cartilage, where this turns round to make the posterior boundary of the nasal opening. So measured, the distance of the ostium is $2\frac{3}{8}$ inches, or 6 cm. When the ostium is entered, the examining or curetting instrument has on an average a working distance of from 1 to 2 cm. ($\frac{3}{8}$ to $\frac{3}{4}$ inch). Owing to the high position of the ostium, the sinus fills with secretion during the night, and empties itself in the morning when the patient assumes the upright position and bends forward.

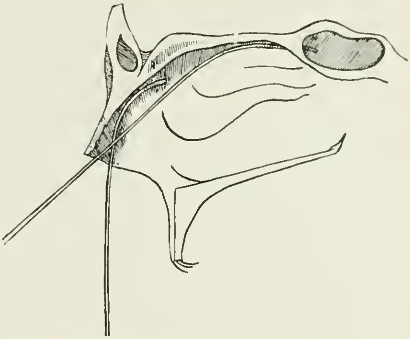

Fig. 174.—Diagram Showing one Method of Catheterizing the Sphenoidal Sinus. (Sieur and Jacob.)

Catheterizing the Sphenoidal Sinus. (Fig. 174.)—Unless the olfactory slit is widened as a result of atrophy of the soft parts, the ostium of the sphenoid cannot be seen. In many cases, however, the middle turbinate can be pushed aside by means of Killian's long thin-bladed speculum, and the opening of the sinus exposed. In those cases in which the ostium is visible, catheterizing is done under direct sight and is a simple procedure. As the average distance from the front wall of the sphenoid is a fraction over three inches, and the average depth of the sinus three-quarters of an inch, the catheter should be at least four inches long. If the front wall of the sinus is exposed by the speculum, but not the opening, the catheter is carried back to the sphenoid under direct vision, is placed against the upper part of the front wall, and the point is turned slightly outward behind the posterior end of the ethmoidal labyrinth, and then brought downward on the front face of the sphenoid and rotated a little in the search for the opening. If the Killian speculum is not at hand, or if the patient will not permit its use, an attempt may be made to pass the catheter back to the front wall through the olfactory fissure. There is practically always a passage back in the olfactory fissure, just below the cribriform plate. If this route is to be followed, the patient's head should be thrown slightly upward and backward. A catheter, which is bent about twenty degrees away from the horizontal, is pushed up to the cribriform plate in the anterior part of the olfactory fissure, and then carried back along the under surface of the cribriform plate to the upper part of the front wall of the sphenoid. The greatest gentleness must be used in order to prevent the catheter from engaging against the cribriform plate and perforating it. When the catheter is against the front wall of the sphenoid the point of the instrument is brought downward and rotated until the ostium is found. If the catheter has too much of a bend it will not engage against the front wall of the sinus, but will slip down into the pharynx.

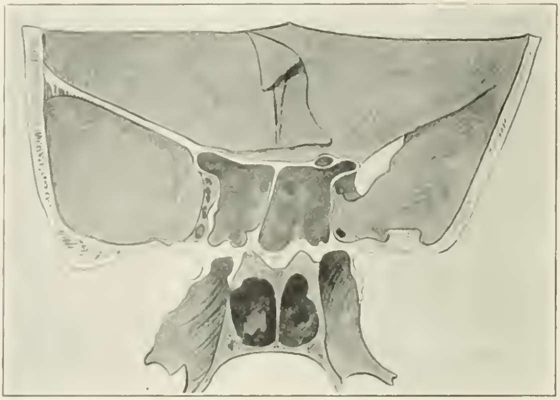

FIG. 75.—The Prolongation of the Sphenoidal Sinus into the Lesser Wing. On the right the optic canal is shown in the roof of the prolongation. (Sieur and Jacob.)

A probe passed upward at an angle of forty-five degrees with the floor of the nose is in direct line with the front face of the sphenoid and the ostium. Such a line cuts the lower border of the middle turbinate at its centre. By following this line one can catheterize forty per cent of sinuses. Great care should be used in passing a probe vertically upward in front of this line for fear of striking and perforating the cribriform plate.

The sphenoidal sinus can be catheterized by a third method, viz., by placing the catheter against the lower part of the front face of the sinus, then working the point upward, and fishing for the opening.

THE SPHENO-ETHMOIDAL RECESS.—Just in front of the anterior face of the sphenoid, and separating this from the posterior ethmoidal cells, there is a vertical slit which is called the spheno-ethmoidal recess—the remnant of the sixth meatus. The height of the recess is 12 mm. (½ inch), and its width 5 or 6 mm. (¼ inch). Some of the posterior ethmoidal cells empty into this, as does also the sphenoidal sinus. The mission of this slit is to carry secretion from the posterior ethmoidal cells and from the sphenoidal sinus down to the pharynx. Thus it is that pus seen by the posterior mirror in the superior meatus and on the upper rim of the choanæ serves as a sign of disease either in the sphenoidal sinus or in the posterior ethmoidal cells.

PROLONGATIONS OF THE SPHENOIDAL SINUS.—Important as the relations of the different faces of the sphenoid are, it is of even greater clinical importance to appreciate the fact that the sphenoidal sinus frequently sends out prolongations.

In rather rare cases prolongations are found running into the posterior clinoid processes or into the beak of the sphenoid. These prolongations are not common and are not important. There are three varieties, however, which are not only common, but very important. These are:

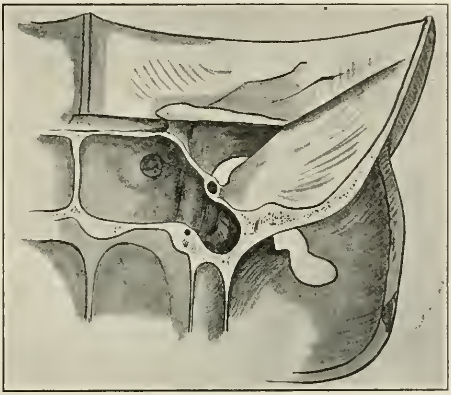

FIG. 176.—The Prolongation of the Sphenoidal Sinus into the Great Wing. The circular dark area in the upper wall of the prolongation is the foramen rotundum, and the smaller one in the lower wall is the Vidian canal. (Sieur and Jacob.)

1. A prolongation into the lesser wings. (Fig. 175.) The importance of this is that it tends to weaken the optic groove and, in cases of trauma, to determine the site of fracture here. Then, again, it furnishes a good route along which pus from a suppurating sinus may travel to the optic nerve and infect it. This prolongation occurs once in twelve cases.

2. A prolongation forward at the anterior inferior angle of the sinus. This is called the palatine prolongation, because it comes into relation with the palate bone. (Figs. 177 and 178.) The name maxillary prolongation or antrum prolongation would suggest better its anatomical and clinical bearings.

At the posterior inferior part of the ethmoidal region there is an ethmoidal cell (Fig. 179) which plays the rôle of a go-between between the sphenoid behind and the antrum in front. This cell is normally in relation with the outer half of the anterior face of the sphenoid. It corresponds to the anterior inferior angle of the sphenoid and to the posterior superior angle of the antrum. It may be absorbed by the antrum or by the sphenoid. When the cell is absorbed by the sphenoid a cul-de-sac is formed which runs obliquely forward, outward, and downward. It may be from 4 to 6 mm. (⅙–¼ inch) broad and 5 or 6 mm. (¼ inch) long. Often the partition which separates this prolongation from the antrum is made of thick bone, but again it is common to have it composed of translucent bone, which could easily melt down in the presence of pus.

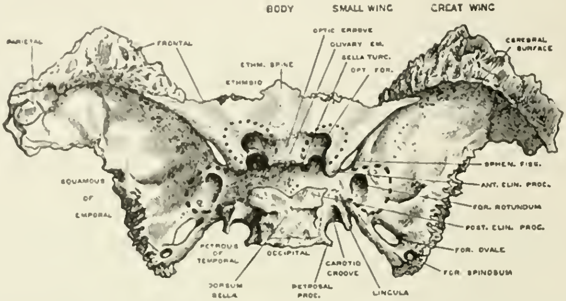

FIG. 177. The Prolongation of the Sphenoidal Sinus into the Great Wing and into the Lesser Wing. The dotted lines show the position of the prolongations. (Quain, with modifications.)

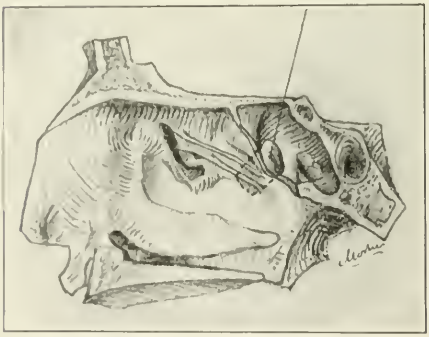

FIG. 178. Prolongation of the Sphenoidal Sinus Forward. (Four-fifths natural size.) This prolongation, called the antral prolongation makes a part of the posterior superior inner wall of the antrum. The bone at the anterior or blind end of the prolongation is as thin as paper and could easily be broken down by the necrosing action of pus. Through such a prolongation a diseased antrum could readily infect the sphenoidal sinus, or the sphenoidal sinus, when diseased, could infect the antrum. This prolongation is very common. (Original.)

Above this prolongation are the posterior ethmoidal cells, of which this prolongation is a derivative. Below and toward the inside is the spheno-palatine foramen, and to the outside, in the spheno-maxillary fossa, is the superior maxillary nerve, with the spheno-palatine or Meckel's ganglion hanging from it; behind are the spheno-maxillary fossa and, directly below, a part of the superior meatus. The importance of this prolongation is that it unites the sphenoid and the antrum. The endeavor was made, at one time, to enter the sphenoid through the posterior superior angle of the antrum, where this prolongation is so frequent. There were too many important relations at this point, however, and the way was too narrow, for the procedure to become much used.

3. A prolongation into the great wings of the sphenoid and into the base of the pterygoid plate. (Fig. 178.) It is the most common prolongation. This is found once in six subjects, and is seen only in large sinuses. It is often greater on one side than on the other, or may even be unilateral. It projects outward between the foramen rotundum and the foramen ovale—that is, between the superior and the inferior maxillary nerves. Sometimes the prolongation extends down the side of the choanæ for a distance of 5 or 6 mm. (¼ inch). In one case out of six, where the prolongation is found, it reaches as far outward as the foramen ovale. When it extends as far outward as this the cavity is separated from the two nerves and the two foramina by a thin partition of bone, or, in some instances, only by mucous membrane. This prolongation explains readily the involvement of the two maxillary nerves in affections of the sphenoidal sinus. Where this prolongation is present there is danger, in the operation for resecting the Gasserian ganglion at the foramen ovale, of breaking into the sinus. On account of the widening of the floor of the sinus the Vidian nerve is in the floor of the prolongation and consequently is exposed. Whenever the two choanæ are found to be very large it should arouse a suspicion that this prolongation exists.

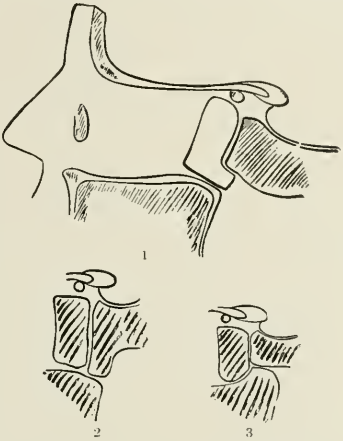

Fig. 179.—Diagrams Showing Different Relations between the Antrum, the Ethmoidal Cells, and the Sphenoidal Cells. (Sieur and Jacob.)

1, the largest figure, shows a posterior inferior ethmoidal cell between the sphenoid behind and the antrum in front.

2, the lower left-hand figure, shows the posterior ethmoidal cell united to the sphenoid and making the antrum a prolongation of the sphenoidal sinus.

3, the lower right-hand figure, shows the antrum increased in size by the absorption of this cell.

Modern study of the anatomy of the sphenoidal sinus has brought out two important points. The first relates to the rapidity of development, up to fifteen years. *x*-ray plates and autopsy findings show that at ten years of age the sinus may be as large as what is given as the normal size for the adult sinus—that is, it may measure, from before backward, three-quarters of an inch. At autopsy, in a boy of ten, I found it to measure in this diameter one inch. In the examination of adult heads my experience has been that it is more common to find a sinus which measures an inch or more antero-posteriorly than to find one which measures three-quarters of an inch. The second important point is the great frequency with which the sinus is found to have prolongations. The commonest of these is the prolongation outward into the great wing, between the foramen rotundum in front and the foramen ovale behind, that is, between the superior maxillary nerve and the inferior maxillary nerve. The intimate relationship between this prolongation and these two important nerves makes the examination of the sphenoidal sinus, in cases of neuralgia, of the greatest importance. This prolongation drains poorly at best, and the drainage is made poorer by the frequent presence, on the outer wall of the sinus, of a partial partition which projects somewhat over its opening.

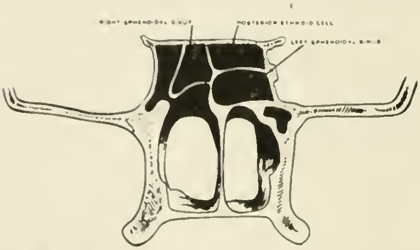

Fig. 180.—Specimen Showing an Ethmoidal Cell Extending Back Over the Sphenoidal Sinus. (Sieur and Jacob.)

Modern anatomy has taught us how the posterior ethmoidal cells may overlie and surround the sphenoidal sinus (Fig. 180), at times almost taking its place, and it has also emphasized the intimate relationship between the sinus and the optic nerve.

Pathology.—Acute Inflammation of the Sphenoidal Sinus.—Acute inflammation of the sphenoidal sinus is accompanied, as a rule, by severe general symptoms, among which are mental depression, sleeplessness, and attacks of fainting. There is pain either in the occipital or in the frontal region. At times the pain may be located in the region of the ear. Vertigo may be present, and there is generally a sense of pressure behind the eye of the affected side. The nose is stopped, and there is loss of smell. The nasal mucous membrane is red, especially in the region of the superior meatus and the olfactory fissure. In this locality there may be seen a little pus which is renewed as soon as it is wiped away.

Acute inflammation of the sphenoidal sinus can cause ocular disturbances such as swelling of the lids, exophthalmos, diplopia, and dimness of vision. Acute inflammation of this sinus has been known to lead to a fatal meningitis.

Unless the symptoms are stormy or complications are threatened, the diagnosis of acute inflammation of the sphenoidal sinus is in many cases only a probable diagnosis; and, where this is the case, the treatment is purely symptomatic. If local treatment is called for, it consists in washing out the sinus or enlarging its drainage opening.

Chronic Inflammation of the Sphenoidal Sinus.—In chronic inflammation of the sphenoidal sinus any or all of the symptoms which have just been given for acute inflammation may be present. The symptoms, however, are generally milder. In some cases the patient complains of severe post-nasal catarrh, while in others he mentions also dryness of the pharynx, discomfort in the larynx, and hoarseness. The post-nasal catarrh is due to the dried secretion on the walls of the pharynx; the sense of dryness, to the atrophy of the mucous membrane caused by the suppuration in the sinus; and the hoarseness, to crusts and scabs in the larynx. In ozæna of the larynx our suspicions should be directed to the accessory sinuses, and, first of these, to the sphenoid. Afternoon somnolence is commoner in sphenoidal disease than in disease of the other sinuses. Severe eye symptoms are, as a rule, late symptoms, though they may be the first symptoms noticed by the patient. Often the symptoms are those of a posterior ethmoiditis, such as mental depression, inability to carry on work, and disturbances of vision.

The Varieties of Chronic Inflammation of the Sphenoidal Sinus.—(1) Mucocele. —Mucocele of the sphenoidal sinus, with gradual dilatation of the cavity of the sinus, is less common in the sphenoid than in other sinuses. A few cases have been reported. In two of these there were bilateral exophthalmos and blindness from atrophy of the optic nerve.

The diagnosis of mucocele of the sphenoidal sinus can be made only by opening the sinus and evacuating thick, sterile mucus. The dilatation of the sinus could probably be proved best by use of the *x*-ray.

(2) Chronic Suppuration.—Most cases of chronic inflammation of the sphenoidal sinus are cases of persistent suppuration. The pus from chronic suppuration in the sphenoidal sinus may perforate the median partition between the sinuses and fill both cavities; it may also bore a way for itself forward into the posterior ethmoidal cells; or it may break into the antrum through the antral prolongation of the sphenoid. When the pus works its way through the roof of the sinus or through the outer walls the consequences are more serious. In such cases there are disturbances of vision from compression neuritis, or thrombosis of the cavernous sinus with its attendant eye symptoms. In addition, there may occur basal meningitis, extradural abscess, or abscess of the brain in the middle fossa.

Examination.—Pus is found in the superior meatus and in the olfactory fissure. From here some of it reaches the floor of the nose, but the greater part gravitates to the pharynx. The vault is filled with scabs and the posterior pharyngeal wall is matted thick with them. Scabs and pus are found on the back of the soft palate and about the rim of the choanæ. Polypi are not generally present in connection with suppuration of the sphenoid. The posterior end of the middle turbinate may be enlarged. The olfactory fissure is not wide enough, as a rule, to allow the ostium of the sphenoid to be seen. In many cases, however, it can be brought into view by using the long-bladed speculum. The most important point, in making a diagnosis of chronic suppuration in the sphenoidal sinus, is to catheterize the sinus and to wash pus from it.

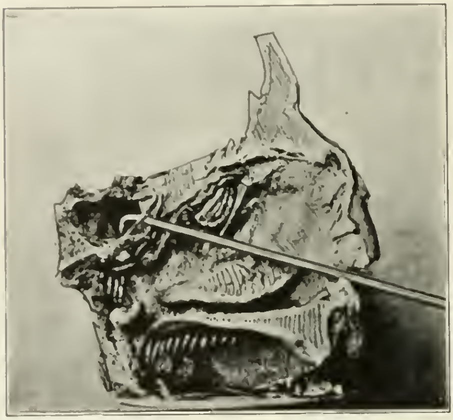

FIG. 181.—Dissection, to Show How Hajek's Hook Can Be Used for Breaking Down the Front Wall of the Sphenoidal Sinus. (Original.)

Treatment.—So far as treatment is concerned, the sphenoidal sinus may be regarded as the most posterior of the ethmoidal cells. Suppuration in it, therefore, is to be treated in the same manner as suppuration in any ethmoidal cell—that is, by opening and draining it. The first step in the treatment is to expose as much of the front wall of the sphenoid as possible. This is accomplished by removing the posterior half, or, better, by removing the whole, of the middle turbinate. The outer half of the front face of the sphenoid is the posterior wall of the ethmoidal labyrinth. The sphenoid, therefore, can be entered either through the inner half of the front face or through the outer half by way of the ethmoidal labyrinth. (Fig. 181.) Hajek's hook is very useful for beginning the removal of the anterior wall. The hook is placed in the ostium, point downward, and pulled sharply forward and downward. As it tears itself out it takes with it a bit of the anterior wall about the ostium. This procedure can be repeated until the whole front wall is broken away. More accurate work, however, can be accomplished by doing the finishing with a clean-biting conchotome which cuts downward. As the conchotome reaches the lower part of the front wall it bites less well because the wall here is thicker. If the posterior ethmoidal cells have been removed the conchotome can be turned outward and the outer half of the front wall removed. Here, again, the hook can be used, but a conchotome of the proper shape is a much more satisfactory instrument. After the removal of the front wall the cavity of the sinus is washed out. The sinus should never be curetted except in a downward or in an inward direction. If one is tempted to curette in any other direction he should not forget that the ophthalmic artery, the cavernous sinus, and the internal carotid artery lie against the outer wall, the optic chiasma and the pituitary gland against the superior wall, and the medulla and the pons against the posterior wall. The spheno-palatine artery crosses horizontally the lower part of the front face of the the sphenoid. This is always injured if the very lowest part of the front wall is removed. For the removal of the lowest part of the wall the chisel or the burr is necessary, because the wall at this point is so thick. At times, it is necessary to remove some of the anterior portion of the floor of the sinus in order to get sufficient drainage. After such a procedure the bleeding may be severe enough to require a tampon to control it.

When the front wall of the sphenoidal sinus has been removed, careful after-treatment is necessary in order to prevent the formation of a membranous diaphragm in the place of the anterior wall. If this occurs, the drainage of the sinus is obstructed and remains so until the membrane is removed. Any granulations, therefore, which spring up around the edge of the bony opening in the front wall of the sphenoid should be curetted or burned away with silver nitrate. By a thorough opening of the sinus after the method just described, by the maintenance of drainage, and by careful after-treatment, most patients can be made comfortable and many of them cured.

ROUTES BY WHICH THE SPHENOIDAL SINUS MAY BE APPROACHED.—1. *The Anterior or the Ethmoidal Route.*—The straightest and therefore the most surgical route to the sphenoidal sinus is the anterior or the ethmoidal route. This requires a skin incision along the outer border of the nasal bone and the resection of the ascending process of the superior maxilla. In addition, the lachrymal bone and one-half of the os planum are removed. The method of accomplishing these procedures has already been described in the section on chronic inflammation of the frontal sinus. (See page 131.) The whole ethmoidal labyrinth is cleaned out from before backward, and the complete front wall of the sphenoid is taken away under direct vision. This method is slow in becoming popular on account of the scar left in the skin. Wherever there is an empyema involving at the same time the ethmoidal labyrinth and the sphenoidal sinus, I believe that this route is by far the best one. From the mechanical standpoint this operation leads all others; from the patient's standpoint, also, it must be looked upon favorably because everything is accomplished at one sitting and while he is under the influence of an anæsthetic. In this way the patient is spared many partial operations.

2. *The Route through the Inner Wall of the Antrum.*—The sphenoidal sinus can be reached through the upper part of the inner wall of the antrum. This is a serviceable route and one which has been used much abroad.

Technique.—The canine fossa is opened to its widest limit. (Fig. 182.) A thin-bladed knife is pushed through the ostium of the antrum into the nasal cavity, and the knife is carried backward horizontally through the whole length of the membranous area of the inner wall of the antrum. The posterior superior part of the inner wall of the antrum is broken down and removed with the conchotome. At the site of the ostium a curette is passed upward in as nearly vertical a direction as possible, into the ethmoidal labyrinth, and then is carried backward through the labyrinth to the front of the sphenoidal sinus. This has to be done by aid of the sense of touch and by a knowledge of distances. The larger the portion of the inner wall of the antrum that is removed the greater is the working space and the better the view of the sphenoidal sinus. (Fig. 183.) Some operators remove practically all of the inner wall of the antrum, in order to get as complete a view of the sphenoidal wall as is possible. When the front face of the sphenoid is uncovered it is broken down.

As regards directness and effectiveness, this method of procedure cannot be compared with that by way of the anterior route. Furthermore, there is a variation of the posterior ethmoidal cells which makes this route uncertain. This variation has already been described, and consists in a posterior ethmoidal cell of large size, paralleling the outer wall of the sinus. When, therefore, in a case of this kind, one approaches the sphenoid from the antrum it is easy to enter such a cell, to mistake it for the cavity of the sinus, and to leave the sphenoidal cavity proper unopened. I have had this happen repeatedly on the cadaver, although I was on the lookout and took special pains to prevent it. Such a mistake would rarely be made, if at all, in approaching the sphenoid from the front. Working in the ethmoidal region from below and by dead reckoning is never so satisfactory and never so comfortable as working from the front in direct line with the sinus and under direct vision. The sphenoid is never opened by way of the antrum except in cases of suppuration involving at the same time the sphenoid, the ethmoidal labyrinth, and the antrum. The method necessitates working in the dark, and is bloody and mechanically poor.

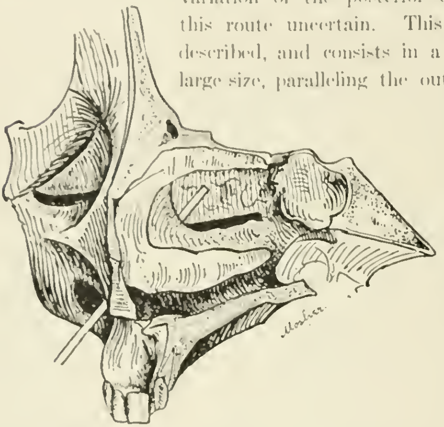

FIG. 182.—Drawing Intended to Show the Method of Reaching the Ethmoidal Cells from the Antrum, and the Incision in the Upper Part of its Inner Wall through which this is accomplished. The anterior end of the incision is at the point where the probe entered—a point which corresponds to the ostium. The crescentic line in front of this is the anterior border of the hiatus semilunaris. From the probe, horizontally backward, the heavy black line is the incision though which the cells have been reached. Above this, the drawing shows how the middle and posterior ethmoidal cells have been cleared away, and farther back it shows how the front wall of the sphenoidal sinus has been broken down. (Original.)

As a matter of completeness, the measurements relating to this operation are given here. A knowledge of them is essential for any safe and thorough work on the ethmoidal labyrinth or on the sphenoid by the antral route.

When one operates for the purpose of establishing an opening in the sphenoid he should introduce a finger through the mouth into the posterior nares, as advised by St. Clair Thomson, as an additional guide to the lower edge of the anterior surface. I have measured fifty half-heads in order to get an idea of the operating distances to the cribriform plate and to the sphenoid. The first measurement is the distance from the centre of the canine fossa back through the posterior part of the membranous area of the inner wall of the antrum to the lower border of the anterior face of the sphenoid. This measurement, it was found, varied from 1½ to 2 inches. Generally it was 2 inches (5 cm.). The angle at which the curette should be carried backward, in order to strike this point, is forty-five degrees. If the curette is not held parallel to the septum there is danger of opening the orbit posteriorly. The distance, straight up through the ostium to the cribriform plate, ranged between 1½ and 1⅞ inches. It is not safe to curette toward the cribriform plate further than a distance of 1½ inches (38 mm., or practically 4 cm.).

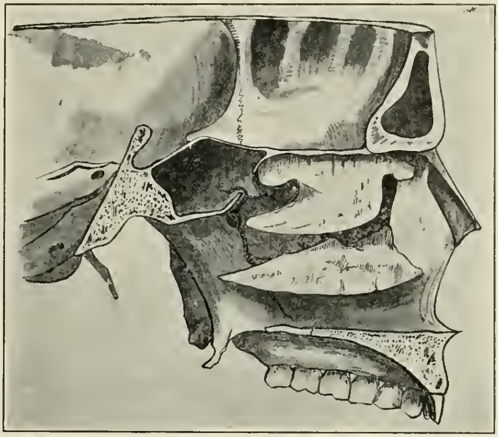

Fig. 183.—This Drawing Shows the Spheno-palatine Foramen and the Branches of the Spheno-palatine Artery that Supply the Sphenoidal Sinus and the Antrum. (Original.)

Let us consider next the inside of this inner wall of the antrum, or, what is the same thing, the outer wall of the nares. The distance from the ostium to the cribriform plate is, on the average, ¾ inch (2 cm.). In one case only did I find it ½ inch. This distance is the working distance of the curette upward. Half an inch, therefore, from the ostium upward is the limit of safety. This measurement (¾ inch, or 2 cm.), which represents the distance from the ostium to the cribriform plate, is also roughly the measurement from the ostium to the anterior face of the sphenoid.

In a great majority of cases the ostium is on a line with the lower edge of the anterior face of the sphenoid. It may be a little above or a little below, but, for surgical purposes, the line from the ostium backward can serve as a guide to this point.

The only vessel which is in danger of being cut in an incision through the membranous area of the inner wall of the antrum is the outer and descending branch of the spheno-palatine artery. This, however, runs down on the ascending process of the palate bone and is not in danger if the incision is stopped a quarter of an inch in front of the posterior angle of the antrum, or if the incision is not prolonged beyond the natural stopping-place caused by the resistance which this process gives to the knife. Unless the incision is pushed farther back, the spheno-palatine ganglion, which is the Gasserian ganglion of the nose, is not in any danger.

The length of the inner wall of the antrum was found to vary from 1⅛ to 1⅝ inches (3 to 4 cm.).

The membranous area was found to vary in diameter between 1 inch and ½ inch (2½ cm.–4 cm.). The average measurement was ¾ inch (2 cm.). I do not see how one may avoid wounding the branch of the spheno-palatine artery, which crosses transversely the face of the sinus below the ostium. It is very reassuring to have a measured curette when one is working in the nose. Such a curette should have the distances of 1, 2, 2½, and 3 inches (4, 5, 6½, and 7½ cm.) marked on the shaft. A ferrale is placed at 1½ inches. When one works straight upward toward the cribriform plate, through the ostium, the ferrule should never be allowed to enter the antrum, but should be kept in the centre of the canine fossa. Anteriorly, the upward limit of safety is 1½ inches. The lower part of the front wall of the sphenoidal sinus is 2 inches from the centre of the canine fossa. When the sinus is entered, the curette can proceed with safety ½ inch farther.

VII. NEOPLASMS OF THE NOSE AND OF THE ACCESSORY SINUSES.*

A. Tumors of the Nasal Cavities.

Benign Neoplasms.

Nasal Polypi.—The most common growth within the nose is the polyp. Polypi arise as a rule from the ethmoidal region and are found in most instances in the middle meatus. They are seen at all ages, but chiefly in adult and middle life. A polyp is an œdematous fibroma which springs from the mucosa or the muco-periosteum, as the result of chronic inflammation. The growth is gelatinous in consistency and pyriform in shape. Small polypi are flat, large ones are pedunculated. The farther back in the nasal cavity a polyp arises the greater the amount of fibrous tissue which it contains.

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* In writing the following chapter on Neoplasms of the Nose and of the Accessory Sinuses the author has used freely the treatises published by Zarniko, Casselberry, and St. Clair Thompson; and to these writers he desires here to express his thanks.

Etiology.—The majority of polypi are due to chronic inflammation of the muco-periosteum and the bone of the ethmoidal labyrinth; that is, they are due to ethmoiditis. The opinion which has been accepted most widely is that the pathological changes begin in the mucosa and then extend inward. The process often causes either a disintegration of the bone or a rarefying osteitis. Another important cause of polypi is empyema of the frontal sinus or of the antrum. The irritation caused by the purulent discharge from either of these sinuses leads to disease of the mucous membrane of the middle meatus and in this way gives rise to the growth of polypi.

Microscopic Appearances.—The body of a polypus is composed of a network of areolar tissue. The meshes of the network are filled with serum. The serum-filled spaces may be so large that the polyp becomes partly or wholly cystic. The serum contains salts in solution and mucin, and in the meshes of the areolar tissue there are threads of fibrin and small round cells. The covering of a polypus is ciliated columnar epithelium. (Fig. 184.)

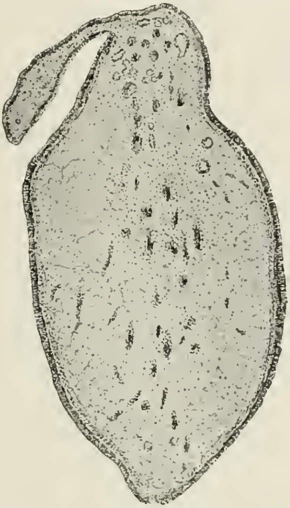

Fig. 184. — Vertical Section of an Ordinary Nasal Polyp. (Magnified 6 diameters.) The upper part of the figure represents the pedicle, and the lower part the body the polyp. (From Zarniko, after Guenther.)

Symptoms.—Occasionally the first symptom indicative of the presence of a nasal polypus is a diminution or a loss of the sense of smell. This is due to the blocking of the olfactory fissure by the polypi. The more usual symptoms are nasal obstruction, a watery secretion from the nose, and headache. In severe cases, in addition to the symptoms mentioned, there is a feeling of intranasal pressure. The speech is defective and in most cases there are aural complications. Sometimes the stimulation or the irritation of the nasal reflexes produces sneezing or asthma.

Nasal polypi may be divided into three groups:—(1) Polypi associated with ethmoiditis; (2) polypi associated with suppuration of the accessory sinuses; (3) polypi associated with vasomotor rhinitis.

(1) *Polypi Associated with Ethmoiditis.*—In some cases of nasal polypi due to ethmoiditis the growths are hidden in the middle meatus, and do not become

visible until the anterior end of the middle turbinate is removed. Generally, however, the polypi can be seen budding from the middle meatus. Where the disease has existed for a long time one or more large polypi may completely fill the nasal cavity. A large polypus may present itself at the vestibule or it may fall back into the pharynx. The nose may be filled with a watery secretion; there is, however, no pus.

Symptoms. The common symptoms are partial or complete nasal obstruction. There may be, in addition, a watery nasal discharge and headache. When the olfactory fissure is occluded there is loss of the sense of smell.

As a rule, the removal of the polypi restores the ability to smell. When the nose is entirely blocked or the polypi are so numerous that they project into the pharynx and interfere with the movement of the soft palate, the character of the voice is altered.

Treatment. When the polypi are small and confined to the middle meatus, or when they are placed high up in the nose, in the olfactory fissure, it is necessary to remove the anterior end of the middle turbinate in order to reach them. Small polypi are best removed with a conchotome. The usual instrument for removing large polypi is the snare. In the employment of the snare the loop of wire is made of such a size that it will encircle the body of the growth easily. The loop is then manipulated about the body of the polyp and pushed upward until it encircles the pedicle of the growth. At this stage of the procedure the loop is narrowed by the écraseur attachment of the snare until the pedicle of the polyp is cut through. In many instances no operative procedure could be simpler; in some cases, however, the successful adjustment of the snare requires a number of trials. This is especially true if the polyp is large. In such instances the wire loop should be at least an inch and a half long and as wide as the nasal cavity will permit. The loop is introduced into the nose at the level of the floor and in a direction parallel with the septum, and it is carried well into the nasal cavity so that it projects beyond the polyp. When it is in place the loop is turned outward and upward about the lower end of the polyp. The operator manipulates the loop in the same manner as a fisherman manipulates a hand-net in scooping up minnows. When the polyp is large or the nose so narrow that the limits of the growth cannot be determined, it is useful, after the wire is in place along the floor of the nose and has been turned outward, to grasp the end of the polyp with a delicate pair of artery clamps and to pull the mass into the snare as the loop is being carried about it. As the loop is forced upward it is gradually made smaller, and then, when it has been carried as high as possible, the wire is drawn tight about the pedicle and the polyp is cut through. Instead of cutting the pedicle of the polyp, one may, in some cases, wrench the growth out with a quick jerk of the cannula of the snare. This procedure often brings away several small polypi which spring from the same base as the large one. When the attempt to adjust the wire loop fails, the polyp is often pushed into the posterior part of the nose. When this happens, if the patient is told to blow, the polyp will be forced to the front again into a position favorable for the application of the wire.

Whenever the polyp springs from the posterior part of the nasal cavity, and especially whenever the body of the tumor falls into the pharynx, it is very difficult to get the wire loop around it. Such a polyp generally has a narrow pedicle. When this is found to be the case, a small hook is the best instrument with which to remove it. When used for this purpose the hook is passed into the nose alongside the septum and carried, if necessary, into the pharynx; and when it has reached this position it is turned outward so as to lie in a horizontal position. If the hook is then pulled forward it engages the pedicle of the polyp and tears through it. After this, the polyp lies free in the nasal cavity or falls into the pharynx. In these rather difficult cases, if the patient can tolerate the manipulations, the physician's finger introduced into the vault may be made to push the polyp forward and fix it while the hook is guided into place. This procedure is so readily executed under ether that the administration of an anæsthetic is often advisable.

Still another procedure that is useful for removing a polyp which projects into the pharynx is to pass a long loop of snare wire through the nose until it falls below the soft palate. The loop is spread with the fingers and allowed to sink back against the pharyngeal wall. Then the ends of the loop which come out of the nose are pulled upon. As the wire ascends it scrapes along the posterior pharyngeal wall so that the polyp often engages in the loop. When the polyp is caught the wire is threaded into the cannula of the snare, and the polyp is removed.

The simple removal of polypi is not sufficient. The mucous membrane from which the growths spring should be removed, and so also should the ethmoidal cells which underlie it. Only by thorough treatment of this kind can the recurrence of polypi be delayed or prevented.

(2) *Polypi Associated with Suppuration in the Accessory Sinuses.*—The constant discharge of pus into the middle meatus from the frontal sinus or from the antrum is liable to cause the growth of polypi.

Where polypi and pus are present in the nasal cavity there is commonly sinus disease back of the polypi. As corroborative evidence of this fact there is generally pain over the affected sinus. Transillumination or the *x*-ray plate will settle definitely which one of the accessory sinuses is at fault.

According to their size the polypi are removed either with the conchotome or with the snare. When this has been done, treatment should be directed to the diseased sinus. The measures required have already been described.

(3) *Polypi Associated with Vasomotor Rhinitis.*—A certain number of cases of asthma are associated with bilateral polypi. In addition to the asthma there may be vasomotor rhinitis. This is shown by severe sneezing. Often

polypi are present, not only in the nose, but also in the antrum. The fundamental pathological condition seems to be a lack of proper vasomotor control. This shows itself in the development of polypi in the middle meatus or in œdematous swelling of the nasal mucous membrane.

Diagnosis. Cases of asthma or vasomotor rhinitis, which have no other pathological lesion in the nose except polypi, are classed in this group.

Treatment. Wherever there are polypi they should be removed. In many cases this calls for opening the antrum. This is best accomplished from the canine fossa. After the polypi are removed from the antrum a large opening should be made from it into the nose, under the inferior turbinate.

Intranasal Fibroma. Polypi which originate in the posterior part of the nasal cavity contain more fibrous tissue than do polypi which are found in the anterior part. A posterior polypus, according to the amount of fibrous tissue which it contains, is classed as a fibro-mucous polypus or as a fibroma. A pure fibroma is rare. A fibrous polypus is single, non-translucent, of a dark color, and hard. It cannot be distinguished from a fibro-sarcoma except by microscopical examination. After removal a fibroma tends to recur. In time it may be supplanted by sarcoma.

A small fibroma which is favorably placed can be removed with the snare. The cold wire loop is generally employed. At times, however, it is necessary to remove the growth piecemeal with a strong punch. In such instances the bleeding is free and requires packing of the nasal cavity. In neglected cases the accessory sinuses are involved, so that an external operation may be necessary in order to reach the growth effectively.

Fibroma of the Vault of the Pharynx. A fibroma of the vault of the pharynx so often invades the nasal cavity, and is so similar in structure to fibroma of the nose, that it is appropriately discussed in connection with intranasal fibroma. The microscope shows that all grades of malignancy are found in fibromata of the vault of the pharynx: some of them being pure fibromata, others fibrosarcomata, and still others angio-fibromata or angio-fibro-sarcomata. Histologically, it may not be permissible to class a fibroma among the malignant growths, but clinically it has some of the characteristics of malignancy. These are, for example, that it tends to recur and that it invades the nasal cavity and accessory sinuses. The growth usually springs from the under surface of the basilar process of the sphenoid or from the occipital bone. It may grow rapidly and invade the nasal cavity and the antrum, the orbit, or the sphenoidal sinus. This variety of new-growth occurs almost always in males between the ages of ten and twenty years. After the twenty-fifth year the tumor ceases to grow and gradually disappears. In some instances it reaches its limit of growth much earlier than this period.

Symptoms. The chief symptoms of a fibroma of the vault of the pharynx are hemorrhage and nasal obstruction. In extensive cases the nasal bones are spread and the deformity known as "frog-face" is produced. After the growth has entirely filled the antrum it appears in the canine fossa and causes the cheek to bulge. Where the tumor extends rapidly or has been neglected it grows outward into the spheno-maxillary fossa and rises from here into the temporal fossa. It may appear below the soft palate and so interfere with speech as well as with swallowing and breathing. In the cases that end fatally death is caused by hemorrhage, pyæmia, or cerebral involvement. (See Fig. 185.)

Diagnosis.—Repeated or severe hemorrhage from the nose in a boy or a young man should raise the suspicion of the existence of a fibroma in the vault of the pharynx. Examination with the mirror shows a bluish-gray or a pinkish tumor springing from the vault. If there is a prolongation into the nasal cavity this can be seen by looking into the nose. A fibroma can hardly be mistaken for an adenoid if a clear picture of it is obtained in the mirror, but it might be mistaken for an adenoid when examined with the finger. An adenoid, however, is not so firm as a fibroma, and is situated in the middle line, whereas a fibroma often has its chief attachment to the side of the vault. An adenoid bleeds but little on manipulation, whereas a fibroma bleeds excessively. The exact nature of the growth cannot be ascertained until a piece is removed for microscopical examination.

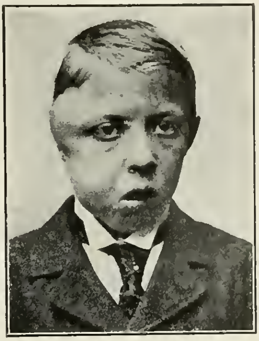

Fig. 185.—Spread of the Disease in a Case of Fibroma of the Vault of the Pharynx. (From Zarniko.) The growth had a prolongation in each nasal fossa. It filled the right antrum and broke through the canine fossa. The right spheno-maxillary fossa was filled by the growth, which from here extended into the temporal fossa.

Prognosis.—A fibroma of the vault which appears in early youth, and is allowed to go on untreated, generally ends in death. When the growth starts near the age limit,—that is, about the twentieth year,—it may undergo retrogressive changes and disappear. Cases have been reported where the growth has been destroyed and cured by sloughing. When the growth is seen early and it can be removed frequently, the prognosis is favorable.

Treatment.—The aim of treatment is to keep the growth at a minimum size until the patient reaches the age when the tumor stops growing of its own accord. The more malignant the tumor the oftener it will have to be removed. For the first few years this may mean an operation once or twice a year. It may be put down as an axiom that the whole of the growth cannot be gotten out at one operation no matter how prolonged or extensive the operative procedure may be. Only in the most neglected cases or in those of the most malignant type is it necessary to resect the superior maxilla. This has been a common practice even for a fibroma of a low grade of malignancy, but it is no longer considered good surgery.

The danger of the operation lies in hemorrhage. Knowing this, the operator should make up his mind what procedure is best adapted to the case in hand, and the operative measures should be executed quickly and thoroughly. Time should not be lost by experimenting with different types of instruments. The most useful instruments are: a heavy snare, which carries a strong wire and has an écraseur attachment; a heavy ring punch, with a curve so disposed that it will reach the vault of the pharynx when carried up behind the soft palate; and a stout ring punch which is not too large to be passed through the upper part of the nose into the pharynx. The Farlow snare and Coffin's fibroma punch are two instruments very well adapted for removing the fibroma.

The index finger of the left hand should be kept in the pharynx in order to guide the wire loop around the tumor or to guide the punch. The ring punch of medium size, such as is used in work upon the tonsil, is also very useful. It is important that the punch should not grasp tissue blindly, but should always be directed by the finger tip. In this way every stroke of the punch accomplishes something, the cartilages of the Eustachian tubes are protected from injury, and the operator knows when his work is finished. The practice of tying one or both of the external carotid arteries is coming more and more into favor in order to lessen the hemorrhage and to delay recurrence of the tumor by diminishing its blood supply. If it is decided to tie both arteries it is well to tie one of them under cocaine a week before the operation. Only in young individuals, or where the growth is very extensive or very malignant, is it necessary to tie the external carotid. The patient can be operated on with the head hanging over the end of the table, or he can be strapped into a chair in the sitting position. If the carotid is not to be tied I prefer the sitting position.

Technique of the Operation with the Snare.—The snare is used to the best advantage when the patient is in the sitting posture.

The removal of a fibroma with a snare is successful only when the growth is pedunculated. Unless the growth is so formed that the loop of the instrument can be engaged about it without serious difficulty the snare should be abandoned. It is a common mistake for operators to persist in the attempt to use the snare when such difficulties are encountered. The cannula is threaded with stout piano wire, and the loop is passed through the side of the nose which gives the best access to the base of the tumor. The finger in the pharynx guides the wire about the tumor and pushes it upward round the pedicle. After the wire is in place, if the growth is large enough, a pair of curved double hooks is passed through the mouth into the pharynx and snapped into the base of the tumor. The head of the patient is bent forward and the growth is cut off by slowly screwing home the écraseur attachment of the snare. If the procedure is successful the detached tumor falls out of the mouth under the guidance of the double hooks. Before the operation is begun a narrow tape should be passed through one nostril and brought out of the mouth. This is drawn tight and slipped down over the lip in order to bring the palate forward and to keep it out of the way of the finger in the vault of the pharynx. To the lower half of this tape a plug of gauze, of fairly large size for the post-nasal space, is tied. If much hemorrhage follows the removal of the growth, the plug should be firmly crowded into the vault of the pharynx. When there is but little bleeding, the ends of the tape may be tied and the plug left hanging on the patient's cheek, ready for use in case it may be needed later.

Sometimes a wire can be made to engage the tumor if a long thin clamp, such as is used in operations in the pelvis, is passed through the nose and adjusted on the base of the growth. With the clamp in place a loop of wire is passed over the handle of the clamp and guided by the shaft of the instrument into the pharynx. When the loop reaches the pharynx it is manipulated with the finger about the growth and over the projecting end of the clamp.

The Technique of the Removal of a Fibroma with the Punch.—In the writer's experience the removal of a fibroma is more often successfully effected with the punch than with the snare. It is exceptional, however, to find a fibroma so pedunculated that the snare will remove more than a part of it, and consequently in most cases the base of the growth has to be removed with the punch. After the snare has removed a reasonable part of the growth, it should be discarded for the punch. If the growth is not pedunculated the snare should not be tried. When the punch is used, the finger should guide it into place about the tumor before the blades are shut. Fibromata are so hard that even the strongest punch may not cut through them cleanly. In these cases the tumor must be torn out piecemeal. In this tearing lies the chief danger. Fibromata grow, as a rule, from the base of the sphenoidal bone, on the under surface of the sphenoidal sinus. In some instances they even invade the cavity of the sinus. It is better, therefore, in order to avoid opening the sinus, to bite off the growth as cleanly as possible. If the sphenoidal sinus is opened and suppuration is started within it, a fatal meningitis is practically sure to follow. A large opening into the sinus is safer than a small one, because the larger the opening the better the drainage. When the sphenoidal sinus is opened, the presence of a post-nasal plug is very dangerous, because it tends to force the infection from the base of the sloughing tumor into the sinus.

If, after the removal of a fibroma, symptoms of meningitis set in, both sphenoidal sinuses must be opened at once.

A fatal case of the writer's illustrates this point. The autopsy on this case showed that the right sphenoidal sinus was full of pus and had caused a basal meningitis. The left sphenoidal sinus had been opened at the operation. This sinus, however, was found at the autopsy to be clean. Before the death of the patient the left sphenoidal sinus had been suspected and had been washed out. Before the death of the patient also an attempt was made to examine the right sphenoidal sinus without the aid of a general anæsthetic, but the examination was unsatisfactory. In this case the posterior nasal plug started up a suppuration in the left middle ear, and later it was found necessary to perform a mastoid operation. As evidences of meningitis, however, set in, an operation was performed on the lateral sinus and the cerebellum was explored. All this time the focus of the trouble was located in the right sphenoidal sinus. The post-nasal plug had caused trouble, not only with the middle ear on the left side, but also with the sphenoid on the right.

After the body of a fibroma has been removed through the pharyngeal route the base of the tumor can be dealt with directly by passing the tonsil punch through the upper part of the nose. The application of the punch to the tumor is guided by the finger in the vault.

Harmon Smith recently reported a case in which he caused a fibroma to slough away by injecting into it monochloracetic acid. The injections, some fourteen in all, were made with Smith's modification of a syringe devised by Coffin. The patient was a boy of sixteen.

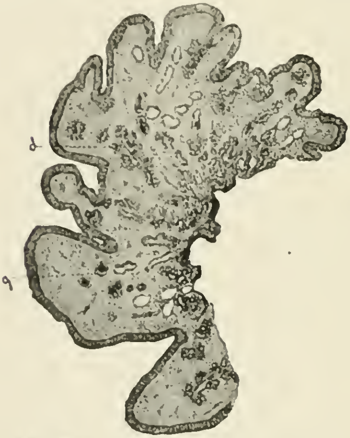

Fig. 186.—Intranasal Papilloma removed from the Septum (Magnified 6 diameters.) (From Zarniko, after Guenther.) *d*, Glandular structure, *g*, blood-vessel.

The essential point to remember about fibroma of the vault of the pharynx is that resection of the superior maxilla is seldom necessary.

Intranasal Papilloma; Fibroma Papillare.—Papillary fibroma, commonly called a wart, is found usually in the vestibule of the nose. It can grow from any part of the nasal cavity, but the favorite places are the septum and the floor of the nose. The growth may be of the squamous type or it may be soft and vascular, composed chiefly of columnar epithelium. It may be pedunculated or sessile. (Fig. 186.)

Symptoms.—The chief symptoms are nasal obstruction and epistaxis.

Diagnosis. The growth has the white, cauliflower-like appearance so characteristic of papilloma of the larynx. It is very friable. It has not the consistency of epithelioma, but it can be distinguished from malignant disease only by microscopical examination. Often the clinical course of the affection will enable the physician to make a reasonably sure diagnosis. According to Wright, there is little if any tendency to malignant transformation.

Treatment.—The growth should be removed with snare, conchotome, or curette, and its base cauterized with trichloracetic or chromic acid. The growth recurs very rapidly. In a case under the care of the writer at the present time, it is necessary, in order to keep ahead of the growth, to remove it at least every six weeks. In this case it has been found useful to put a light plug of gauze wrapped in Cargile membrane into the nose after each curetting. The patient removes this herself at the end of twelve hours. This procedure prevents excessive bleeding and keeps the nose from filling with annoying clots.

Intranasal Angioma; Bleeding Polypus of the Septum.—Other names for this affection are: angio-fibroma, fibro-angioma, telangiectoma, and cavernous angioma.

This tumor occurs usually on the anterior inferior part of the septum. As a rule, it is small, varying in size from a pea to a filbert. The surface is nodular and the color mottled blue or red. The base of the tumor may be broad or it may be in the form of a pedicle. This tumor is more frequent in females in the proportion of three to one.

Microscopic Appearances.—The growth is composed chiefly of blood-vessels and blood-channels. The latter are lined with epithelium. The stroma of the tumor is composed of connective tissue, in which there are numerous round cells. The outer surface of the growth is covered with mucous membrane.

Symptoms.—The symptoms of intranasal angioma are frequent and severe bleeding and nasal obstruction.

Diagnosis.—When the interior of the nose is examined a small, nodular, bluish or red tumor is seen springing from the anterior part of the septum. The tumor feels firm when touched with a probe, and it bleeds easily.

Treatment.—Removal of the growth is the proper treatment of intranasal angioma. This is best accomplished with a cold wire snare. The base should be cauterized with chromic acid. After the tumor has been removed it should be examined in order to exclude sarcoma. After thorough removal there is little tendency to recurrence.

Intranasal Adenoma.—An intranasal adenoma is a benign hyperplasia of gland structure. The only symptoms are nasal obstruction. The diagnosis can be made only after the removal of the growth and its examination with the microscope. If it contains no malignant elements the removal of the growth should result in a cure.

Removal by any of the methods just described for the removal of intranasal growths constitutes the proper treatment of an intranasal adenoma. Should the tumor become malignant its removal would call for a more extensive operation by the intranasal route or by way of the canine fossa. If for any reason this is not feasible, resort must be had to an external operation.

Intranasal Osteoma. (**Synonym: Exostosis.**)—A form of exostosis which constitutes an osseous tumor somewhat rarely develops from the wall of the ethmoidal cells or from the walls of the accessory sinuses. In such cases the growth may project into the nose, but as a rule it grows toward the orbit. Osteomata which develop from the diploë are called enostoses, and those which spring from the periosteum exostoses. An osteoma may become free in a sinus by the breaking of the pedicle. Cases have been reported where the growth filled the nose and then invaded the orbit. In one case there were two symmetrically placed osteomata, and the growths were so large that there was spreading of the nasal bones and complete nasal obstruction.

The most prominent symptom is nasal obstruction; and on examination there is found a hard bony tumor which more or less fills the nasal cavity.

Removal of the tumor by some form of external incision is the proper method of treatment. If the growth happens to be small when it is discovered, and if it is confined to the nose, evulsion with strong forceps might effect its removal.

Tooth Cysts.—Cysts arising from the teeth are divided into two classes—follicular cysts and periosteal cysts.

Follicular cysts originate from retained tooth sacs. They may spring from a normal sac or from a supernumerary one. Follicular cysts are true dentigerous cysts. A root is never developed, but a tooth crown may be found in the sac.

Periosteal cysts spring from the covering of the tooth root. They consist of epithelial cells and granulation tissue. They are commoner in the upper jaw and affect especially the lateral incisor and the first bicuspid. These cysts appear in the lower as well as in the upper jaw, but in the lower jaw they are easily overlooked.

Tooth cysts, especially of the follicular type, grow slowly. As they enlarge they make a tumor on the gum. In the ordinary case where the cyst originates from the lateral incisor or the first bicuspid, the swelling may gradually obliterate the canine fossa, and in extreme cases it may push the lip forward. The cyst in time grows backward into the antrum and may occupy nearly the whole of this cavity. In certain instances the cyst grows also downward. In such cases the palate is deformed and a tumor appears in the roof of the mouth. There is but little if any pain connected with the enlargement of the cyst.

DIAGNOSIS.—Follicular dental cysts and tumors are the principal, if not the only, lesions which cause distention of the walls of the antrum. Under pressure of the finger, the walls of a sizable cyst crackle like parchment. If the cyst is filled with pus the *x*-ray will show that the antrum on the side of the cyst is dark. If the cyst has broken down and a fistula leads into it, the cavity of the cyst may be packed with gauze impregnated with subnitrate of bismuth. After this has been done the limits of the cyst are very clearly defined in the *x*-ray plate.

Tooth cysts are usually filled with a straw-colored fluid. If the cyst becomes infected this fluid assumes the character of pus. If the contents do not become infected, a dentigerous cyst enlarges slowly and painlessly, often attaining a large size only after the lapse of years. In the care of his teeth the patient discovers the growth and comes to the physician with the impression that he is suffering from malignant disease. The diagnosis of the true condition is based on the following facts: the slow, painless course of the tumor, its situation in the canine fossa, the absence of nasal discharge, and the yielding of the walls of the cyst under examination with the finger. If a tooth is lacking and if it is ascertained that no tooth has been drawn, the tooth cyst is probably of the follicular type.

TREATMENT.—In the case of a periosteal cyst the tumor should be incised, in order that it may drain thoroughly. Light packing of the cavity may be necessary for a short time. If possible, the tooth which is the source of the trouble should be brought into normal condition. If this cannot be accomplished in a reasonable period of time, the tooth should be extracted. Healing is complete in from three to six weeks.

In the case of a follicular cyst two incisions at right angles to each other are made over the face of the tumor, and the mucous membrane and the underlying periosteum are dissected up in four flaps. Then the bony wall of the cyst is removed flush with the surface of the superior maxilla. After this, the cyst membrane is removed by careful dissection or by curetting. The four flaps are then packed into what remains of the cavity of the cyst and are made to cover the denuded bone as well as possible. The after-treatment consists in the renewal of the packing every few days and in the stimulation of the granulations with iodine preparations or with a paste of subnitrate of bismuth and vaseline. In cases where the posterior wall of the cyst almost touches the posterior wall of the antrum, it is better to remove the posterior wall of the cyst, to curette the antrum, and then to make an opening into the nose under the inferior turbinate. The anterior half of the inferior turbinate should be removed as well; that is, the case should be treated as if it were a case of empyema of the antrum. If an opening is not made into the nose, the antrum must be packed until its obliteration is brought about. In such cases the flaps of mucous membrane and periosteum help somewhat, but the healing, nevertheless, may require a long time. Where the inferior wall of the cyst makes a mound in the roof of the mouth the mucous membrane of the hard palate should be incised by two intersecting cuts, the flaps dissected up, and the bone which constitutes the under wall of the cyst removed. The flaps are then pushed strongly upward in order to restore the form of the palate. The packing and the obliteration of the cavity of the cyst are carried out through the opening in the canine fossa.

Gallagher reports a case of a follicular cyst near the six-year molar in a boy of eleven years. He also reports a double periosteal cyst connected with the right and left incisors. The roof of each cyst was seen as a mound in the floor of the nose underneath the anterior end of the inferior turbinate. Two incisions were made into each cyst, one from the nose and one from the mouth.

Malignant New-growths.

The most common benign growth in the nose is the œdematous or gelatinous polyp. The growth which occurs next in frequency is some form of fibroma. Even a pure fibroma may have some characteristics of malignancy. This is especially true of fibroma of the vault. Such a growth, as has been said, recurs repeatedly and destroys neighboring structures. This is brought about, however, more by pressure than by actual invasion of adjacent tissues. At the same time a fibroma often contains elements which are actually malignant. These are of the sarcomatous type. All grades of malignancy are found, from the fibroma containing a few sarcomatous elements to the tumor which is pure sarcoma of the most virulent character. The chief malignant growths of the nose are sarcoma and carcinoma.

Sarcoma.—Sarcoma is more common than carcinoma. It springs in most cases from the upper part of the septum. The next place where it occurs oftenest is the ethmoidal labyrinth. Seldom is it found on the outer wall or on the floor of the nose. When it occurs in the antrum it has generally made its way there from the nasal cavity. It can, however, arise in the antrum primarily and extend inward to the nose. Carcinoma originates in the antrum more often than sarcoma. Sarcoma occurs earlier than carcinoma. It may even occur in infancy, but, as a rule, it occurs most frequently before middle life. In certain fortunate cases the sarcoma is attached to the septum by a pedicle. More often, however, the growth has a broad base.

Symptoms.—The important symptoms of intranasal sarcoma are obstruction and bleeding. Pain may be an early or a late symptom. In some cases there is but little pain. In advanced cases the nasal bones are spread apart by the growth, the antrum is filled by it, and the tumor protrudes into the canine fossa, causing the cheek to be pushed forward. As in the case of fibroma of the vault of the pharynx, the tumor may make its way through the spheno-maxillary fossa to the side of the face, and then extend upward into the temporal fossa. In neglected cases it finally reaches the brain through the floor of the anterior or middle fossa of the skull.

There is scarcely any doubt that a pure fibroma or a fibroma of a low grade of malignancy occasionally becomes highly malignant. There has been much discussion as to whether ordinary nasal polypi ever change into malignant tumors. The present feeling is that in rare instances they may undergo such a change. The belief that this is a somewhat common occurrence is based upon the facts that the irritation caused by a malignant growth, concealed perhaps in the ethmoidal labyrinth, occasionally excites the growth of simple polypi, and that these polypi, being pliable tumors, readily work their way into parts of the nasal cavity where they can be seen. In addition, sarcoma of a low grade often runs a long course (that is, from two to six years) before the fatal issue occurs. In such instances polypi can be removed a number of times, at rather long intervals, before the sarcoma which pushes them into view is discovered.

Prognosis.—If a sarcoma springs from the septum by a pedicle, it can be thoroughly removed. In such instances, therefore, the prognosis is good. Where, however, the growth involves the ethmoidal labyrinth it is seldom possible to accomplish its complete removal. For an operation to be successful, therefore, it is necessary that the diagnosis should be made early. The routine use of the *x*-ray helps very much to bring this about.

Diagnosis.—A history of nasal obstruction and epistaxis, in a child or a young adult, should make the physician at once suspicious of the presence of sarcoma. Whenever it is possible, an *x*-ray plate should be taken at once. This will show whether or not the sinuses are involved. The nasal examination in most cases discloses the presence of a tumor. This may be of any color or size, and as a rule it bleeds easily on manipulation.

Treatment.—The only effective treatment of an intranasal sarcoma is the removal of the tumor. If the growth is of moderate size and if it springs from the septum by a pedicle, it may be snared off and a generous amount of the septum taken away at its base. It is of little moment if a perforation of the septum follows. In neglected cases, where the antrum is full of the growth and there has been an extension into most of the other sinuses, operation should not be advised. In cases which have not reached this stage it often requires good judgment to select those which are suitable for operation. The non-operating specialist generally advises against surgical interference. The patient, however, should be given the benefit of an operation if, after careful consideration of all the factors in the case, there seems to be a reasonable chance that the growth may be eradicated. The great prejudice against operation has been on account of the external deformity which follows such radical interference. In many early cases it may be possible to avoid this by entering the nose under the upper lip, opening the canine fossa, and removing the inner wall of the antrum. This is the method of Denker. Unless the walls of the antrum are actually involved (not merely absorbed by pressure), the resection of the superior maxilla is not necessary. Where the walls of the antrum are involved the full Ferguson incision, combined with the removal of half of the upper jaw, is required. (See article on "Diseases of the Jaws," in the present volume.) Inoperable cases should be given the benefit of the serum treatment advocated by Coley. (See Vol. III., page 454.)

Carcinoma.—Intranasal carcinoma is less common than sarcoma. Carcinoma is rarer in the nose than in other parts of the respiratory tract, and rarer in the nose than in other parts of the body. The different varieties of intranasal carcinoma are enumerated here in the order of their frequency: epithelioma, cylindrical carcinoma, glandular carcinoma, and hard or scirrhous carcinoma. The places where carcinoma usually appears are the vestibule, the cartilaginous septum, the middle and the inferior turbinates, and the ethmoidal region. Often carcinoma arises in the antrum, and from here invades the nose. It does this much oftener than sarcoma. In many cases carcinoma in the antrum represents simply an extension of the disease from the alveolar border of the superior maxilla.

The symptoms of intranasal carcinoma are pain, nasal obstruction, and epistaxis. These symptoms are the same as those which are found in cases of sarcoma.

Carcinoma usually appears after forty years of age. On examination of the nasal cavity a nodular or cauliflower-like growth is found. This can be differentiated from sarcoma only by the removal of a piece of the growth. The differences between sarcoma and carcinoma may be summed up as follows: Sarcoma has a tendency to form tumor-like masses, while carcinoma tends to eat away tissue; sarcoma spreads through the nasal cavity, but carcinoma destroys it; carcinoma bleeds more than sarcoma; sarcoma occurs by preference in children and young adults, while carcinoma is encountered mainly in middle-aged and elderly people.

The prognosis of intranasal carcinoma is usually bad.

The proper treatment of intranasal carcinoma is early and thorough removal. Intranasal operation seldom offers any hope of success. The external operations are the same as those recommended for sarcoma. They are described in detail in the article on "Diseases of the Jaws," in the present volume.

B. Tumors of the Accessory Sinuses.

New-growths in the accessory sinuses may be either simple or malignant. The simple growths include œdematous fibromata (myxomatous polypi), cysts, and osteomata. The chief malignant growths are sarcoma and epithelioma. New-growths in the sinuses are not common. They are found most often in the antrum.

The Antrum.—The simple growths of the antrum are polypi and cysts. Cysts are caused by obstruction and dilatation of the glands of the mucous membrane, or are due to cystic degeneration of polypi. Cysts are at times large enough to encroach upon the cavity of the antrum. Those which spring from the teeth sometimes force their way back into the antrum and almost obliterate it. The malignant growths of the antrum include epithelioma, sarcoma, and carcinoma.

The Frontal Sinus.—Cysts, osteomata, and fibromata are the non-malignant growths which occur in the frontal sinus. Carcinoma and sarcoma are very rare in this region.

The Ethmoidal Labyrinth.—Osteomata or exostoses occasionally occur in the ethmoidal labyrinth, but the common new-growth in this locality is the ordinary non-malignant polyp. Carcinoma is not rare; neither is sarcoma. Both usually occur at middle life or later. Sarcoma, however, has been found as early as the fourth year.

The Sphenoidal Sinus.—Polypi are not as common in the sphenoidal sinus as in the other accessory sinuses. New-growths seldom originate in this sinus, but they grow into it from without. Of the new-growths which invade the sphenoidal sinus the most important are fibromata or fibro-sarcomata arising from the vault of the pharynx. The other malignant growths are carcinoma and sarcoma.

Differential Diagnosis.—Partial or complete nasal obstruction, combined with epistaxis, should lead to a careful examination of the nose, especially if the patient is approaching old age. If, in addition to nasal obstruction and hemorrhage, the patient complains of pain, the supposition is very strong that malignant disease exists. External deformity and the enlargement of the related lymph nodes are late signs. By the help of the *x*-ray and by early resort to an exploratory incision, cases of malignant disease of the accessory sinuses should not be permitted to reach the inoperable stage before the diagnosis is made.

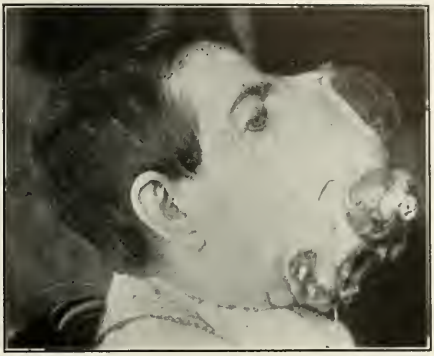
Fig. 187.—Fibro-Myxo-Osteo-Sarcoma of the Left Maxillary Antrum and the Upper Jaw. Case of Dr. S. W. Allen; operation at the Massachusetts General Hospital by Dr. S. J. Mixter; recovery.

Treatment.—In most instances simple nasal polypi are due to some suppurative condition in the ethmoidal labyrinth or one of the other accessory sinuses. The operative measures for their removal have already been in great part described. The statement will bear repeating, however, that mere snaring off of a polypus produces but little if any curative effect. After a polypus has been removed it is necessary to break up the ethmoidal cell underneath the mucous membrane from which the growth springs. Since the greater number of intranasal new-growths originate in the antrum the treatment of such cases often calls for partial or complete resection of the superior maxilla. (See Fig. 187.) Complete resection of the superior maxilla, with the usual Ferguson incision, gives the best approach to this cavity, the ethmoidal region, and the sphenoidal sinus. It is, however, a disfiguring operation and should be reserved for extreme cases. When it is done, the traditional method should be somewhat modified. No attempt should be made to isolate the superior maxilla by incisions through the bone, with the expectation of wrenching it out in one piece. It is better to take the bone away piecemeal with chisel and bone forceps, proceeding carefully under the illumination of a forehead light until normal tissue is reached beyond the growth. In carrying out this procedure the surgeon should have the patient laid flat on the table and he should pass a rubber tube the size of the little finger into either nostril and down through the pharynx to the tip of the epiglottis. The pharynx is then packed with gauze. In this manner the blood is kept from entering the trachea. The two tubes which come out of the nose are pushed over the prongs of a Y-shaped tube made of hard rubber. To the stem of the Y a single rubber tube is then attached, and, to the end of this, a small glass funnel. The etherization is carried on either by placing gauze in the glass funnel and pouring the ether upon it, or by connecting the supply tube with the ether-vapor machine. If it is preferred to use a cone for the etherization the glass funnel can be placed in this and the ether poured into the cone. This does away with the danger of the ether running down the tube into the patient's pharynx. It is better to tie the external carotid before removing the superior maxilla. The great advantage of working with a forehead light or a head mirror cannot be insisted on too strongly. Only good illumination will enable the operator to get beyond all suspicious tissue in the depths of the ethmoidal region or in the spheno-maxillary fossa.

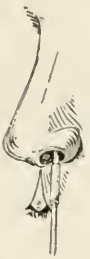

FIG. 188. Drawing Intended to Show the Point from which Measurements are Taken. (Original.)

Where the growth does not involve the alveolar border of the superior maxilla, but springs rather from the inner wall of the antrum or invades the antrum from the nose, it may not be necessary to make the external incision of the usual full length. Denker has developed an operation which does away with the external skin incision. He makes a long incision through the mucous membrane over the canine fossa. The incision begins beyond the frenum of the upper lip and runs round, under the malar process of the superior maxilla, upon the posterior surface of this bone. In the next step the nose is freed from its attachment to the rim of the nasal notch, and the vestibule is retracted upward. Then the bone over the canine fossa is taken away, and with it the bone forming the nasal notch. The next step is the removal of the inner wall of the antrum. When all these steps have been carried out, both the antrum and the lower part of the nasal cavity are freely accessible. For growths of moderate extent this method will often be found to be sufficient. The advantage of the method, apart from the non-employment of an external incision, is to be found in the fact that is saves the roof of the mouth. In cases, however, where there is much involvement of the ethmoidal region it may be necessary to add an external incision along the outer side of the nasal bone and to remove the ascending process of the superior maxilla, either with the burr or with the bone forceps. Only early diagnosis will make this less disfiguring operation advisable. Even in such cases, if it is found not to give a sufficiently large operating field, it should be discarded at once and the full external skin incision made in order that the superior maxilla may be thoroughly removed. In many cases of malignant disease of the antrum the orbital wall of the superior maxilla can be left. It is an advantage to do this because the eye is liable to drop when the upper wall of the antrum is removed. When the growth has invaded the orbit, the eye must also be removed. When this has to be done, no operation upon the head is more formidable or more disfiguring. In determining whether it is justifiable or not to attempt an operation in extreme cases of malignant disease of the antrum, the *x*-ray will be found a great help. By means of this an idea can be gained as to how many of the other sinuses are involved. In the future, more desperate cases will be saved than have been saved in the past, if the operator will carefully pack the pharynx and carry on the etherization by tubes passed through the nose; and if, in addition, he will tie the external carotid and remove the diseased tissue bit by bit, not *en masse,* and will avail himself of the good illumination afforded by a forehead lamp. In inoperable cases or in cases of recurrence the influence of the *x*-ray should be tried. In inoperable cases of sarcoma the patient should be given the treatment by toxins so long championed by Coley. In all instances where there is a reasonable doubt, potassium iodide should be given for a short time. Unless immediate improvement follows, the use of the drug should be abandoned for some operative procedure.

VIII. MEASUREMENTS FOR OPERATING DISTANCES IN THE NOSE.

In order to get an idea of the operating distances in the nose, I made a series of measurements upon sixty-four half-heads representing at least fifty whole heads. The measurements were made on wet specimens. The numbers printed in heavy-faced type (Figs. 188 and 189) represent the measurements which occurred the greater number of times, not the mathematical average. The numbers printed in small type, before and after the central figures, represent the maximum and the minimum measurements. Certain of these measurements have been duplicated by others. As their measurements, however, were made from the middle of the nasal opening, they are greater than mine. My measurements were made from the lower edge of the posterior rim of the nasal opening. All vertical

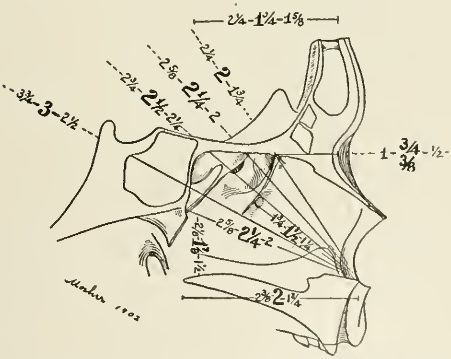

FIG. 189.—Operating Distances Obtained from the Measurement of Sixty-four Half-heads. The measurement of the distance to the lachrymal duct is not given on the diagram. The average distance is one inch. (Original.)

measurements were made close to the junction of the septum and the cribriform plate. If measurements are not made in this way, the probe enters the lateral mass of the ethmoid, where it rises up like a mound above the cribriform plate, and the measurements are increased from one-eighth to one-quarter of an inch. Since most of us visualize inches and fractions of inches more readily than we do centimetres, the measurements are given in these.

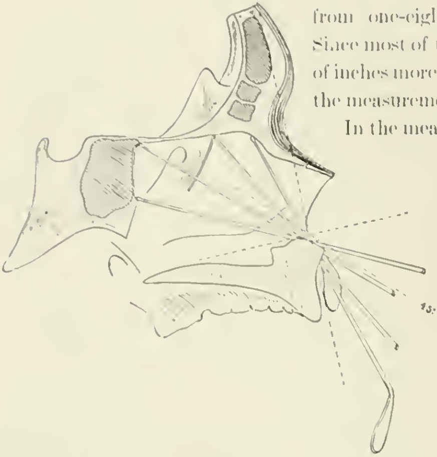

Fig. 190.—Drawing Intended to Show the Angles at which a Probe Must be Introduced in Order to Touch the Various Points of the Nose. (Original.)

In the measurement from the upper end of the infundibulum horizontally forward to the root of the nose, the upper of the two central figures is the average distance; but, owing to the slope of the posterior wall of the frontal sinus forward, the working distance is much smaller. The lower of the two central figures is the average working distance. The smallest working distance which I found in this place was $\frac{1}{4}$ inch; the greatest, $\frac{1}{2}$ inch.

In order to find the relation between the measurements made on the cleaned skull and those made on the wet specimen, I measured fifty-six skulls. In these the average measurement to the cribriform plate at the upper end of the infundibulum was $1\frac{7}{8}$ inches. The maximum and the minimum measurements were $2\frac{1}{8}$ and $1\frac{1}{2}$ inches. The average measurement of the distance to the anterior wall of the sphenoidal sinus was $2\frac{1}{8}$ inches; the maximum and minimum, $2\frac{1}{16}$ and $1\frac{7}{8}$ inches respectively. This shows that in wet specimens and in the living human being, from $\frac{1}{8}$ to $\frac{1}{4}$ inch has to be added to the measurements made on the cleaned skull.

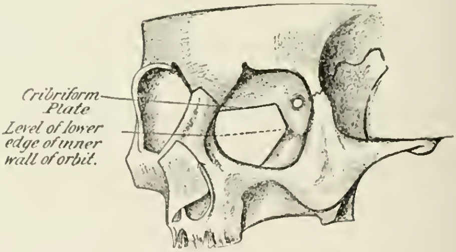

Fig. 191. Drawing Intended to Show the Level of the Cribriform Plate. The inner wall of the orbit and a part of its floor have been taken away. (Original.)

These measurements on the cleaned skull were made from the lower edge of the nasal notch, the deeper of the two openings being taken when they were not alike. A difference in the depth of the two openings is fairly common. However, in the rather coarse measurements which are possible in life, this occasional difference between the two sides can be disregarded.

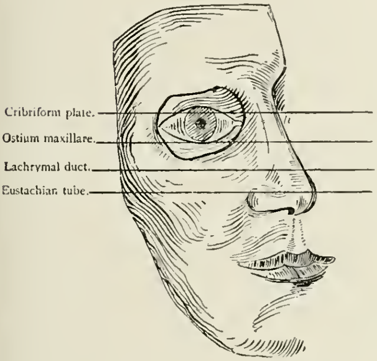

Fig. 192.—Drawing Intended to Show the Horizontal Planes of the Cribriform Plate, the Ostium Maxillare, the Lachrymal Duct, and the Eustachian Tube. (Original.)

My material offered but little opportunity for establishing the ratio between the different measurements and any of the diameters of the skull. I experimented a little with the anterior-posterior diameter; but nothing came of it. Gruenwald tried for something of the same sort, but established nothing. Personally, I feel that heads vary so much that it is not likely that any ratio of practical importance will ever be found. At present, all that can be done is to expect large measurements in large heads, and the reverse in small heads. I found, however, that the smallest measurements occurred in heads with toothless jaws.

The results of these measurements are given in Fig. 189. The position of the lachrymal duct is not given in this figure. The lower opening of the duct is placed under the anterior end of the inferior turbinate, about two-thirds of the way to the opening of the antrum. This would make the average distance one inch.

In making the measurements of the floor of the frontal sinus I was struck with the fact that if a burr is entered at the upper end of the infundibulum and passed directly upward in order to open the frontal sinus, it will, in the majority of cases, enter the cranial cavity. This is due to the fact that the posterior wall of the sinus frequently slopes sharply forward. In order to enter the sinus from this spot, one should point

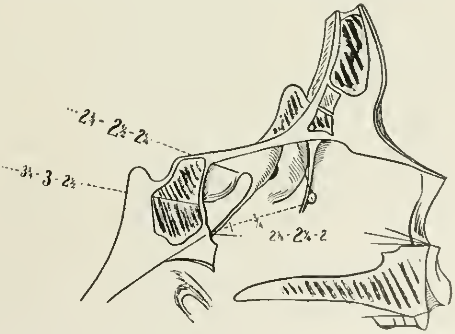

Fig. 193.—Diagram Showing the Outer Wall of the Nose, with Operating Measurements. (Original.)

the burr forward at an angle of forty-five degrees. This would give a working distance of half an inch. If the probe is to pass straight up into the sinus, it must be held parallel with the teeth and close to them. The direction which the probe must take in order to touch the various parts of the nose is shown in Fig. 190. From this diagram, which is taken from a tracing of a probe held in these different positions, it will be seen that, in order to touch the sphenoid bone, the instrument must be at an angle of forty-five degrees, or between this and an angle of 67.5 degrees.

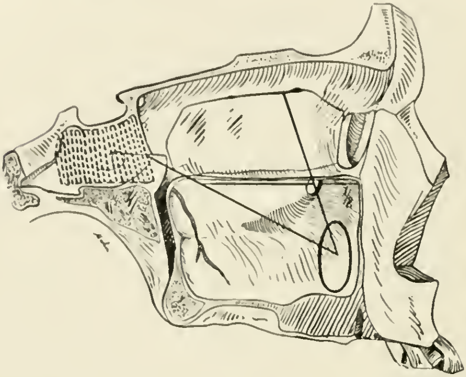

FIG. 194.—The Large Circle Represents the Operating Opening in the Centre of the Canine Fossa; the Smaller Circle, the Ostium of the Antrum. The artery in the posterior part of the inner wall of the antrum is the descending twig of the outer branch of the spheno-palatine artery. The posterior line, drawn from the centre of the canine fossa obliquely backward, represents the distance to the lower border of the anterior face of the sphenoid. The anterior line, which runs upward and slightly backward from the centre of the canine fossa, passes up through the ostium of the antrum to the cribriform plate. The fraction (½ in.) printed in the upper forward angle represents the distance of the ostium from the front wall of the antrum. (Original.)

In a majority of my specimens I found that a line drawn one-quarter of an inch above the lower rim of the orbit, and carried horizontally backward, passed through the ostium maxillare; that a line drawn one-quarter of an inch below the rim cut the lower opening of the lachrymal duct; and that a line drawn one-half of an inch below the rim passed through the upper border of the opening of the Eustachian tube. Fifty cleaned skulls gave the level of the cribriform plate as the mid-point of the inner wall of the orbit, and

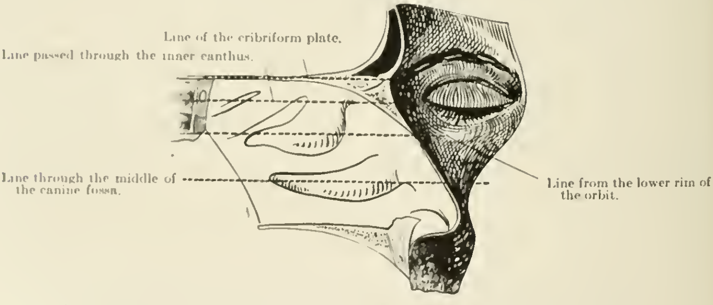
Line of the cribriform plate.
Line passed through the inner canthus.
Line through the middle of the canine fossa.
Line from the lower rim of the orbit.

FIG. 195.—Diagram to Show Horizontal Planes for Operating Purposes. (Original.)

wet specimens showed that this point is one-eighth of an inch above the inner canthus of the eye.

These levels, I scarcely need to state, are not absolute. The opening of the antrum may be on a level with the lower rim of the orbit, not one-quarter of an inch above it. In the same way, the openings of the lachrymal duct and the Eustachian tube may move up; but the level of the cribriform plate—and this is the important one—I found to be rather constant.

I recognize fully the variability of these measurements, and the fact that their total number is small. In spite of this, they furnish a very considerable amount of help. (See Figs. 191, 192, 194, and 195.)

IX. TRANSILLUMINATION.

In favorable cases much information can be gained about the frontal sinuses and the antra by transillumination. The room in which the tests are made should be absolutely dark. A photographer's focussing cloth, thrown over the head of the patient and the head of the examiner, and gathered up snugly to the patient's body and held tightly by the patient, answers as well as a dark room. If the cloth is used, the examining chair should have a rod running above the patient's head so that the hood can be kept away from the hair.

The lamp used is a small five-candle-power electric ten-volt globe, of about one ampère current. The antrum lamp should have a glass hood which can be removed and sterilized. The best frontal-sinus transilluminator has two lamps (Fig. 196), one at either end of an adjustable U-shaped handle. By such an apparatus both sinuses can be lighted up at the same time and slight differences between the two easily compared.

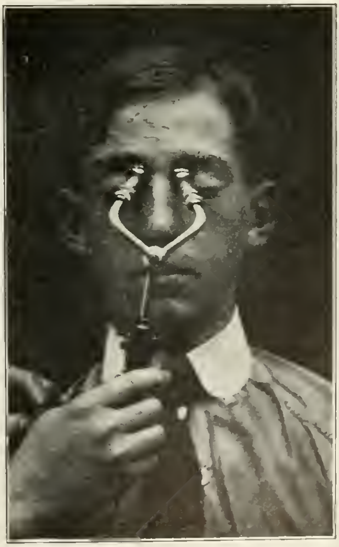

Fig. 196.—Frontal Sinus Transilluminator. (Birket.)

Transillumination of the Antrum. (Fig. 197.)—Transillumination of the antrum, on account of its large size, is more satisfactory than transillumination of the frontal sinus. False teeth should first be removed. The light is placed in the mouth, and the patient is told to close the lips. In a normal antrum the following results are noticed:

1. The pupils of the eyes stand out as dull red balls.

2. As the current is switched on, the patient has a subjective sensation of light. This may be intensified when the eyes are closed.

3. There is a diffused glow of light over the lower part of the cheek and between the teeth.

4. There is a semilunar patch of light outlining the lower rim of the orbit. The light which causes this comes from the antrum. The glow over the lower part of the cheek can be disregarded, but it is essential to obtain this semilunar patch of light above it. Not all of these signs are always present. The first and second are oftenest wanting; the fourth is the essential sign.

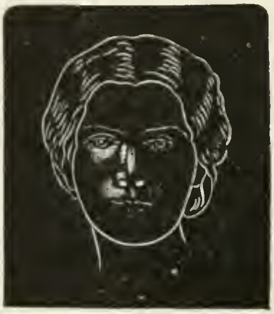

FIG. 197.

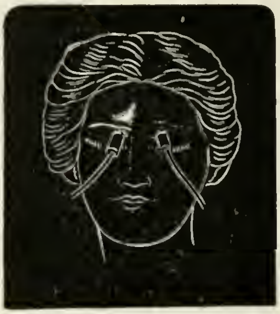

FIG. 198.

FIG. 197.—Transillumination of the Right Maxillary Sinus. The figure shows, on the right side, how the cheek and upper lip are lighted up. A semilunar band of light appears below the eye. This is given by the antrum. The right pupil is illuminated. On the left side these results are absent. (St Clair Thompson.)

FIG. 198.—Transillumination of the Right Frontal Sinus. The figure shows how the sinus on the right side is lighted up and outlined by the light, while the left remains dark. (St. Clair Thompson.)

When there is pus in the antrum, all of these four signs disappear, except the glow between the teeth and a faint glow over the lower part of the cheek. If both antra are affected, the test becomes inconclusive. In patients with heavy bones both antra are often dark. If the sinus happens to be empty, or if the facial bones are thin, the antrum may light up in spite of the fact that it is diseased. Transillumination is much inferior to the use of the *x*-ray for determining the condition of the antrum.

Transillumination of the Frontal Sinus. (Figs. 196 and 198.)—Transillumination of the frontal sinus should not be considered satisfactory unless the light is strong enough to bring out clearly the upper border of the sinus. If partitions are present they also should stand out clearly. It is not enough to obtain merely a supra-orbital glow. The examiner often has to be satisfied with this ill-defined glow, but no conclusions can be drawn from it. Where one sinus stands out clearly, with its upper margin well defined, while the other sinus is dark, we may conclude either that the sinus of this side is not large enough to come forward out of the orbit into the region of the brow, or else that it is sufficiently large and that it is full of pus. Here, again, the examination with the *x*-ray gives more information than transillumination. It will locate the sinus and will define its limits, and at the same time it will, in the great majority of cases, indicate the presence of pus. Transillumination, therefore, is to-day of use mainly as furnishing confirmatory evidence.

X. THE USE OF THE *X*-RAY.

In the *x*-ray we have our most valuable aid in the diagnosis of sinus disease. The accessory sinuses are air spaces, and three of the four are near the surface. On the plate, therefore, they show as dark areas with characteristic outlines. The solid bone, however, which surrounds them, throws a shadow on the plate and appears in the negative as a dull milky white. Whenever the sinuses lose their translucency, as they do when the mucous membrane lining them becomes

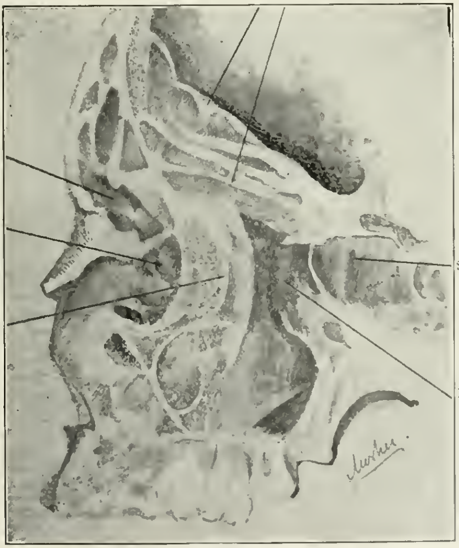
Lines made by the roof of the orbit.
Naso-frontal duct.
Dark area corresponding to the lachrymal bone and the anterior ethmoidal cells.
Malar bone.
Sphenoidal sinus.
Dark area corresponding to the posterior ethmoidal cells.

FIG. 199.—Lateral *x*-ray Plate (reduced one-fourth) Showing Normal Markings. (Original.)

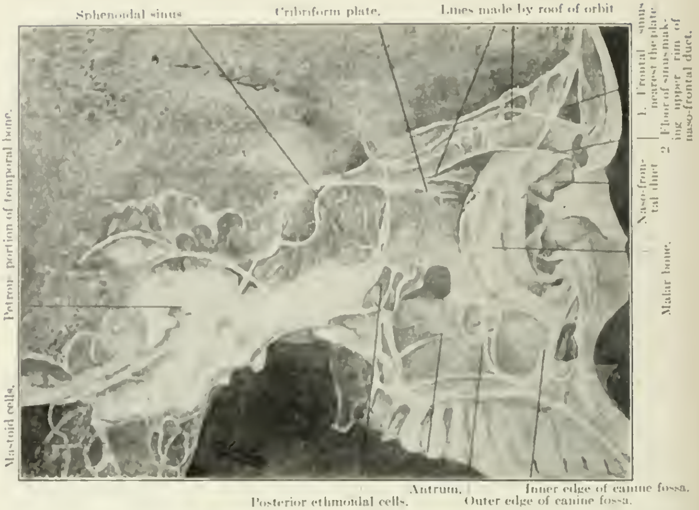
Sphenoidal sinus
Cribriform plate.
Lines made by roof of orbit
1. Frontal sinus nearest the plate
2. Floor of sinus making upper rim of naso-frontal duct.
Naso-frontal duct
Malar bone.
Petrous portion of temporal bone.
Mastoid cells.
Antrum.
Inner edge of canine fossa.
Posterior ethmoidal cells.
Outer edge of canine fossa.

FIG. 200.—*x*-ray Plate (reduced one-third) From a Cleaned Skull, to Show Normal Markings. (Original.) The plate shows how the pictures given by the two halves of the skull usually overlap, the picture given by one half being a little higher than that given by the other. This is seen very clearly in the frontal sinuses and the temporal bones. Owing to this overlapping the floor of one frontal sinus (1) is higher than the floor (2) of the other. The deep shadow cast by the temporal bones and the base of the skull stands out clearly. The projection of this shadow often makes a horizontal white band across the antero-posterior plate unless the *x*-ray tube is so placed that the rays go through the skull above this part of it.

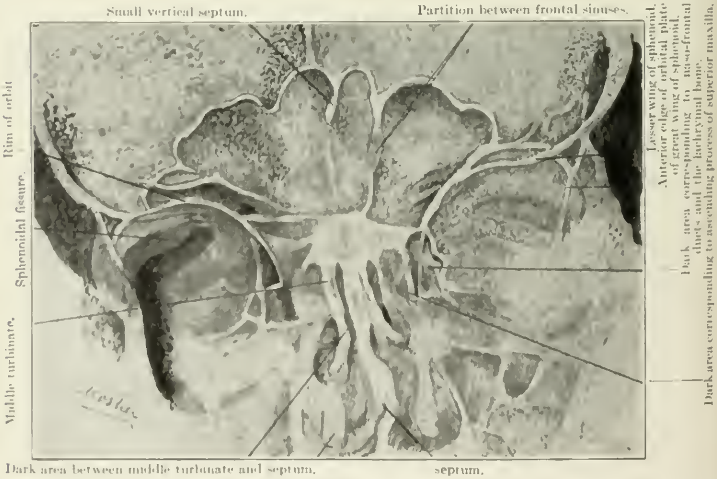
Small vertical septum.
Partition between frontal sinuses.
Lesser wing of sphenoid.
Anterior edge of orbital plate of great wing of sphenoid.
Dark area corresponding to naso-frontal ducts and the lachrymal bone.
Dark area corresponding to ascending process of superior maxilla.
Rim of orbit
Sphenoidal fissure.
Middle turbinate.
Dark area between middle turbinate and septum.
Septum.

FIG. 201.—*x*-ray Plate (reduced one-sixth) From a Cleaned Skull, to Show Normal Markings. (Original.)

thickened, or when they contain fluid or are filled with a new growth, the sinuses also cast a shadow on the plate and become white. It requires considerable experience to read *x*-ray plates correctly. No inferences should be drawn from indifferent plates. In sinus work it is often necessary to try several times before sufficiently good plates are obtained.

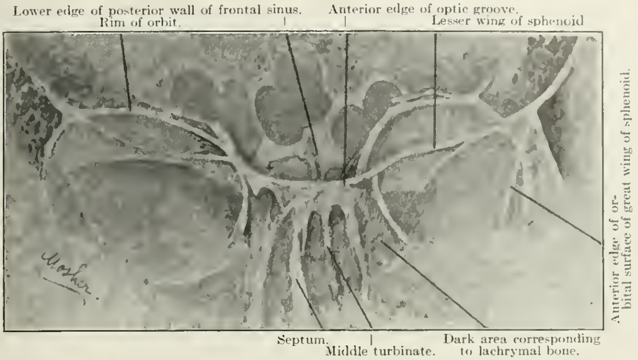
Lower edge of posterior wall of frontal sinus.
Rim of orbit.
Anterior edge of optic groove.
Lesser wing of sphenoid
Anterior edge of orbital surface of great wing of sphenoid.
Septum.
Middle turbinate.
Dark area corresponding to lachrymal bone.

FIG. 202.—*x*-ray Plate (reduced one-sixth) Showing Normal Markings. (Original.)

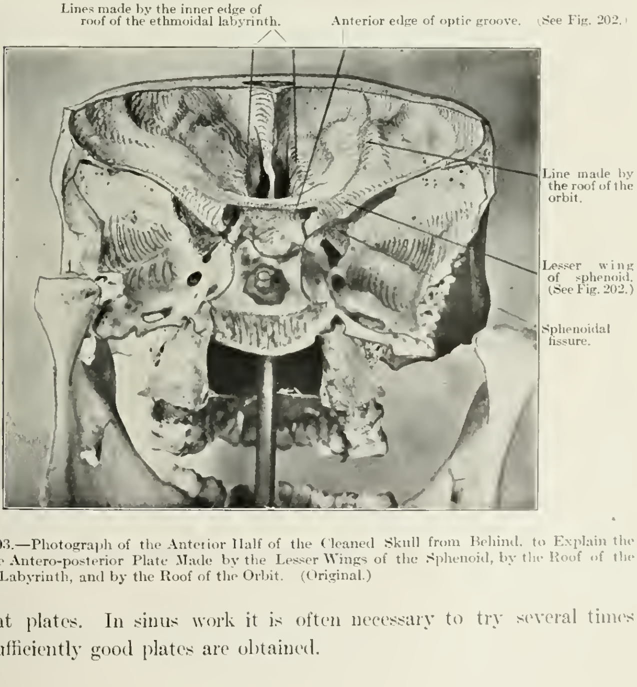
Lines made by the inner edge of roof of the ethmoidal labyrinth.
Anterior edge of optic groove. (See Fig. 202.)
Line made by the roof of the orbit.
Lesser wing of sphenoid. (See Fig. 202.)
Sphenoidal fissure.

FIG. 203.—Photograph of the Anterior Half of the Cleaned Skull from Behind, to Explain the Lines in the Antero-posterior Plate Made by the Lesser Wings of the Sphenoid, by the Roof of the Ethmoidal Labyrinth, and by the Roof of the Orbit. (Original.)

x-ray plates of the head are seldom strong enough to give satisfactory prints, and consequently all judgments have to be made from the plates themselves.

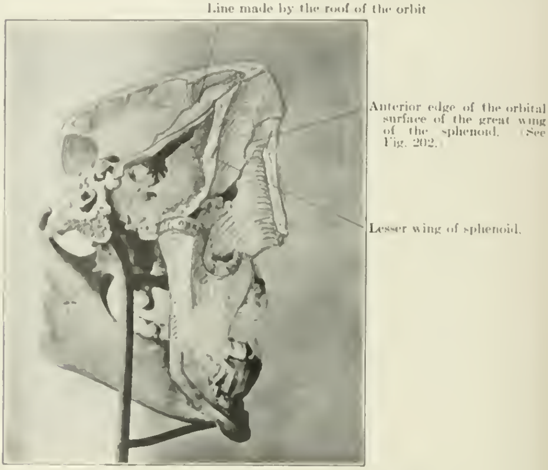
Line made by the roof of the orbit
Anterior edge of the orbital surface of the great wing of the sphenoid. (See Fig. 202.)
Lesser wing of sphenoid.

Fig. 204.—Photograph of the Anterior Half of the Cleaned Skull from the Side, to Show the Lines Made by the Roof of the Orbit. (Original.)

To illustrate the *x*-ray findings in sinus-disease cases, I have collected a number of typical plates from cases upon which an operation has been performed, and also some plates taken from the cleaned skull. I have then made tracings from these plates and have afterward intensified the drawings, endeavoring to exaggerate

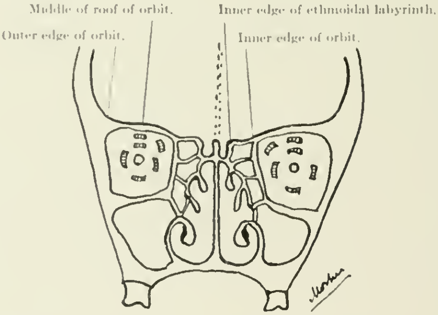

Fig. 205.—Transverse Section of the Skull through the Centre of the Orbits.

Diagrammatic drawing showing the parts of the roof of the orbit and the roof of the ethmoidal labyrinth which give lines in the lateral *x*-ray plate. (Henke.)

the difference between the diseased side of the plate and the normal side as little as possible. Good plates should give differences as marked as those shown in the drawings. In all sinus cases three plates are required: a plate of each side of the head, and an antero-posterior plate. The antero-posterior plate is the hardest to get satisfactorily. One is constantly tempted to make judgments from indistinct plates. An indistinct plate may be good enough to give the location of a sinus and its size, but no judgment can be made from it as to the presence of pus.

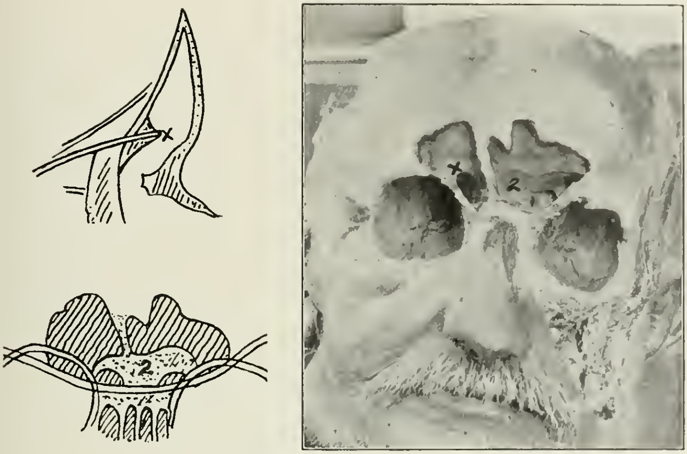

Fig. 206.—Photograph and Diagrams Showing Certain Points in the Anatomical Relations of the Frontal Sinuses. (Original.)

Photograph of a wet specimen from which the anterior wall of the right and left frontal sinuses has been removed. The picture shows where the posterior wall of the frontal sinus ends below and becomes continuous with the floor of the anterior fossa of the skull. At the point marked × is the upper rim of the naso-frontal duct. In the upper left-hand drawing × indicates how this opening appears in the lateral *x*-ray plate. At 2, the photograph shows the thick bone at the junction of the lower edge of the posterior wall of the sinus and the anterior part of the anterior fossa of the skull, in front of the ethmoidal labyrinth. In other words, the picture represents the posterior boundary of the naso-frontal ducts. At 2, in the lower left-hand drawing, is shown how this thickening appears in the antero-posterior *x*-ray plate.

In order to tell which side of the head a plate represents, hold the film side of the plate against your cheek and have the nose on the plate pointing forward. The plate, which in this experiment corresponds to the observer's right cheek, was taken from the patient's right side. The antero-posterior plate is taken with the light at the occiput. The light, therefore, traverses the whole thickness of the head in order to reach the plate, which is placed with the film side against the face. In order to tell which side is right and which left on an antero-posterior plate, it is necessary to hold the plate with the film side toward the observer and to have the orbits in the *x*-ray plate uppermost. When the plate is so held, the observer's right eye corresponds to the patient's right eye, and his left eye to the patient's left eye.

Much disappointment with *x*-ray plates, in sinus cases, has resulted from failure to remember the fact that a diseased frontal sinus at times empties itself, either by discharging through its natural drainage opening or by breaking its way into the orbit. In such cases the *x*-ray findings may be negative. They are especially liable to be negative if the mucous membrane of the sinus has been destroyed. This often happens in frontal-sinus disease associated with exophthalmos. These cases are so striking in appearance that one naturally expects that the *x*-ray picture will be of a typical character. For the reasons just given, however, the *x*-ray findings are often negative.

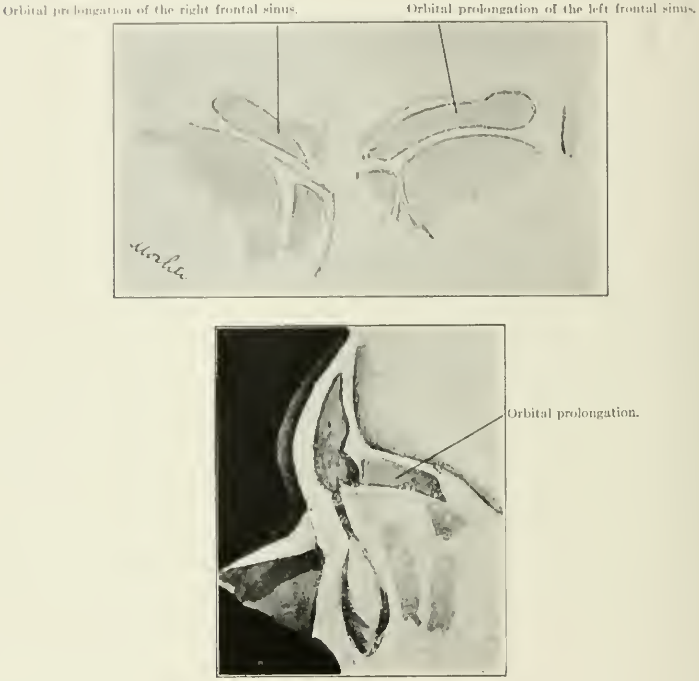
Orbital prolongation of the right frontal sinus.
Orbital prolongation of the left frontal sinus.
Orbital prolongation.

FIG. 167.—*x*-ray Plates (not reduced in size) Showing the Orbital Prolongation of the Frontal Sinus. The upper figure shows the orbital prolongation as seen in the antero-posterior plate, the lower figure the orbital prolongation as seen in the lateral plate.

As the antero-posterior plate is taken from behind forward, a certain number of lines appear on the plate which represent ridges within the skull. The most prominent of these are the two lines made by the free edges of the lesser wings of the sphenoid and the line connecting them made by the anterior edge of the optic groove. The line made by the lesser wing of the sphenoid appears above or below the line made by the roof of the orbit according to the position of the x-ray tube. With the tube directly opposite the occipital protuberance, the sphenoidal lines cut across the orbit about a third of the distance down. As the tube is lowered, the lines advance upward; as the tube is elevated, the lines drop. These lines are well shown in Fig. 202. The roof of the orbit projects upward like a mound into the anterior fossa of the skull, just in front of the lesser wing of the sphenoid. The cranial surface of the roof of the orbit is crossed by many ridges. They run from without inward and from before backward. These lines are so near the plate that the most prominent of them are shown on it. On the antero-posterior plate they roughly parallel the outer part of the line made by the lesser wing, or they intersect it. They rarely run to the middle line. At the upper part of the orbit, therefore, there are often three or four intersecting lines. The great variety of lines which it is possible to have from the sources just described is best realized if we take a cleaned skull

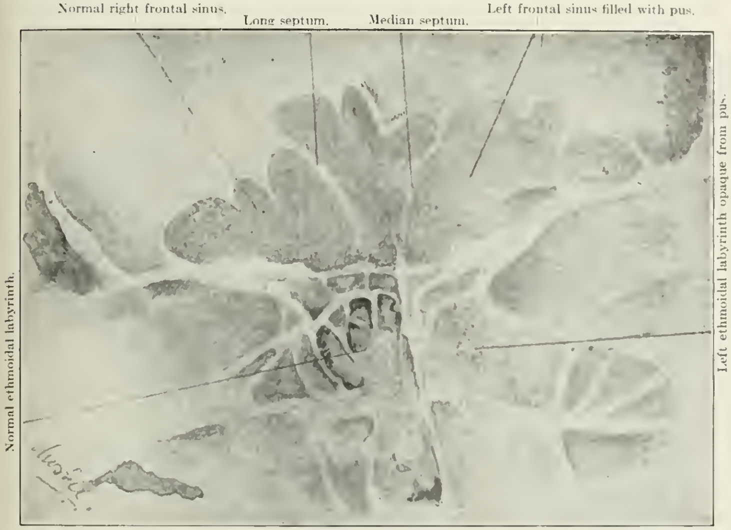
Normal right frontal sinus.
Long septum.
Median septum.
Left frontal sinus filled with pus.
Normal ethmoidal labyrinth.
Left ethmoidal labyrinth opaque from pus.

Fig. 208.—x-ray Plate (not reduced in size) of an Empyema of the Left Frontal Sinus, Left Ethmoidal Labyrinth, and Left Sphenoid. The case is one in which an operation was subsequently performed. The right frontal sinus and the right ethmoidal labyrinth are not diseased; therefore they cast no shadow and appear dark on the negative. The pus in the left frontal sinus and in the left ethmoidal labyrinth casts a shadow, so that these sinuses appear whiter or more opaque than the sinuses of the other side. (Original.)

and, looking into it, mentally project the ridges seen in the middle and the anterior fossæ upon the plate.

The petrous portion of the temporal bone is exceedingly dense. The upper edge of this makes a free line bounding the middle fossa of the skull posteriorly.

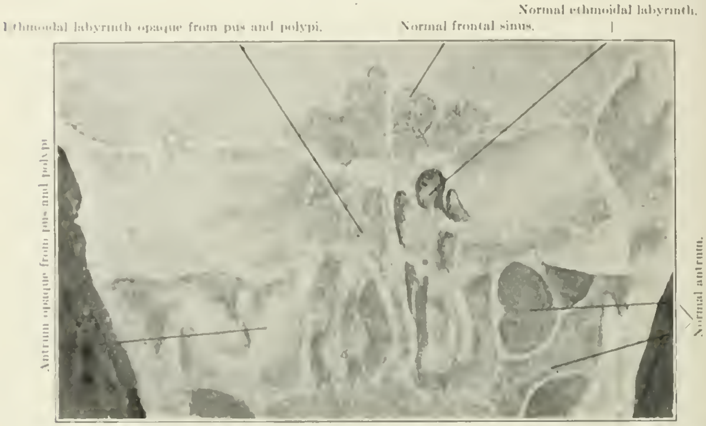
Ethmoidal labyrinth opaque from pus and polypi.
Normal frontal sinus.
Normal ethmoidal labyrinth.
Antrum opaque from pus and polypi.
Normal antrum.

FIG. 209.—x-ray Plate (reduced one-fourth) Showing Disease of the Right Antrum and the Right Ethmoidal Labyrinth. (Original.)

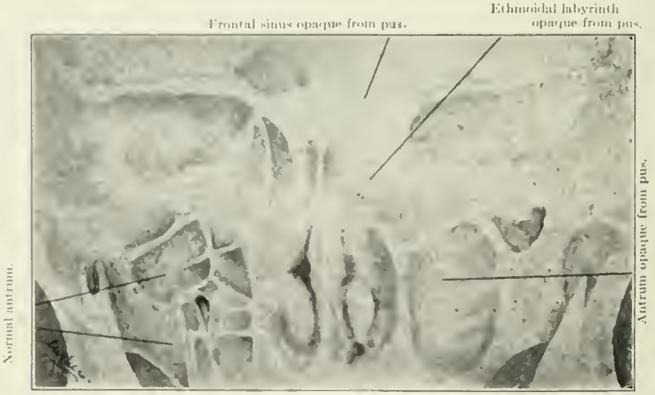
Frontal sinus opaque from pus.
Ethmoidal labyrinth opaque from pus.
Normal antrum.
Antrum opaque from pus.

FIG. 210.—x-ray Plate (reduced one-fourth) of an Empyema of the Left Frontal Sinus, the Left Ethmoidal Labyrinth, and the Left Antrum. In this case an operation was subsequently performed. (Original.)

This line may appear on the plate. Not only is the upper edge of the temporal bone shown on the plate, but the thick body of the bone and the base of the skull are thrown upon the plate and appear as a white band running across the plate from side to side. The lower border of this shadow may run through any part of the orbit or it may come so low as to divide the antrum into an upper dense part and a lower more translucent part. The x-ray operator should know how to place his tube so that this shadow shall not interfere with important parts of the plate. (Figs. 200 and 211.)

In the lateral plate both halves of the head are projected on the plate, the half of the head which is nearer the plate being the more distinct of the two. Owing to the fact that both halves of the head are shadowed on the same plate, a double set of lines is given. These may interlace in a confusing manner. The lines made by the lesser wings of the sphenoid appear again, but are foreshortened. A line is made by the roof of the orbit where it joins the cribriform

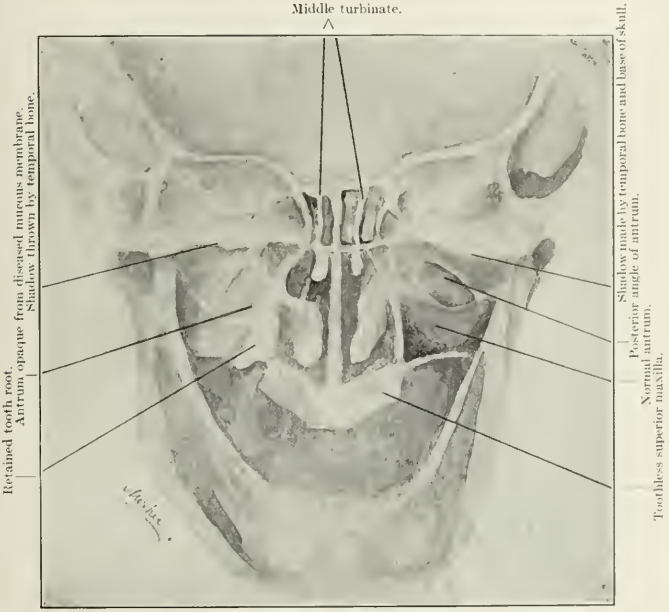
Middle turbinate.
Retained tooth root.
Antrum opaque from diseased mucous membrane.
Shadow thrown by temporal bone.
Shadow made by temporal bone and base of skull.
Posterior angle of antrum.
Normal antrum.
Toothless superior maxilla.

FIG. 211.—x-ray Plate (reduced one-third) Showing Certain Pathological Changes in the Antrum. (Original.)

This plate shows the right antrum opaque from thickened mucous membrane, this condition being due to the inflammatory reaction caused by a retained and necrosing tooth root. At the operation the antrum was found to contain no pus, but the mucous membrane was thickened to about $\frac{1}{32}$ of an inch. This thickening cast almost as much of a shadow as if the antrum had been full of pus or polypi.

At the upper rim of the antrum a white line runs across the plate. From this point upward the plate is much whiter than in the lower part. This opacity is due to the shadow cast by the temporal bones and the base of the skull. It should be the aim of the x-ray operator to avoid this shadow by placing his tube in such a position that the rays will go through the cranium above the temporal bones and the base of the skull. This shadow often spoils a plate, especially in cases of slight disease of the sinuses.

plate, and another one is made where the orbit merges into the lateral wall of the skull. These appear as white lines starting from the anterior part of the roof of the sphenoidal sinus and running obliquely upward and forward to the back wall of the frontal sinus. Some of the lines run into the sinus and partially across it. As all these lines are above the cribriform plate, one is astonished at first to see how low the cribriform plate really is. It should be remembered, however, that the cribriform plate is only an eighth of an inch above the inner canthus of the eye and a quarter of an inch below the top of the nasal bone.

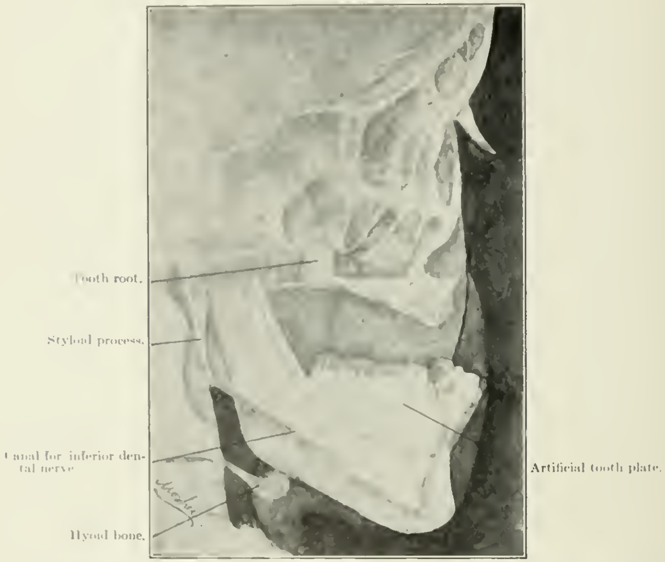

Fig. 212.—*x*-ray Plate (reduced one-third) of a Toothless Upper Jaw with a Retained Tooth Root Projecting into the Left Antrum. An operation was performed in this case. The upper jaw was supposed to be toothless. The patient had worn an upper plate for years. There was a fistula in the alveolus which discharged pus and led through carious bone into the antrum. The antero-posterior plate (see Fig. 211) showed that the left antrum was slightly opaque. At the operation the mucous membrane of the left antrum was found to be thickened to $\frac{1}{32}$ of an inch. There was no pus in the antrum.

In the lateral plate the malar bones stand out prominently. In front of the malar bones there is a dark area which represents the lachrymal bone and the region of the naso-frontal duct, and behind the malar bones there is another dark area which corresponds to the posterior ethmoidal cells. Still farther back is a third dark space, which is the sphenoidal sinus.

The lateral plate will seldom indicate the presence of pus. I once succeeded, in a lateral plate, in getting a fair picture of polypi in the frontal sinus. The antero-posterior plate, therefore, must not be depended upon to tell the presence of pus. A good lateral plate is easy to obtain and it gives valuable information, even if it will not indicate the presence of pus. It will give the height and depth of the frontal sinus, the presence and the size of its orbital prolongation,

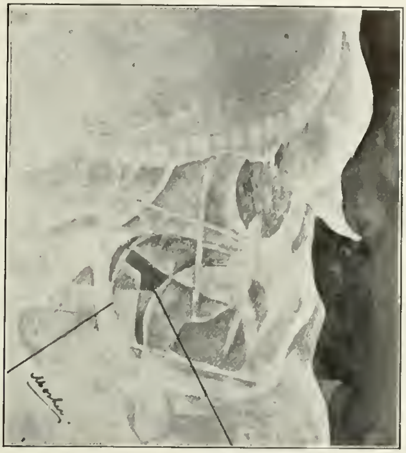

FIG. 213.—*x*-ray Plate (reduced one-third) of a Dentigerous Cyst of the Left Antrum. (Original Case of Dr. D. C. Green.

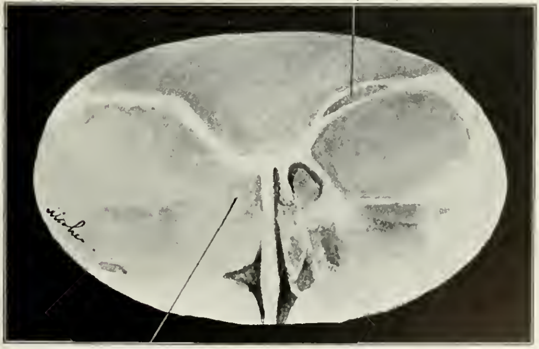

FIG. 214.—*x*-ray Plate (reduced one-fourth) Showing the Right Ethmoidal Labyrinth Diseased and the Left Normal. An operation was performed in this case. (Original.)

and the extent of the basal relationship between the floor of the frontal sinus and the ethmoidal region. It gives the size of the naso-frontal duct and the size of the sphenoidal sinus, and is the only means that we have of getting any idea of the arrangement of the posterior ethmoidal cells. The lateral plate will also give the antero-posterior diameter and the height of the antrum, and it will show the presence of tooth roots in the antrum, the presence of foreign bodies in it, and the size of dentigerous cysts.[1] Further, the lateral plate will show how cellular the mastoid process is.

Foreign bodies in the sinuses appear slightly magnified in the plate. The sinuses themselves are somewhat enlarged, but in a carefully taken plate the enlargement can be disregarded.

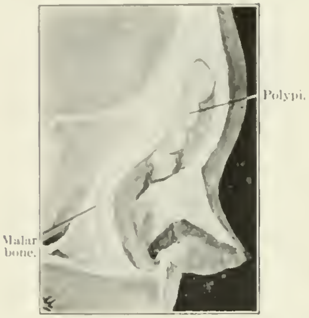

Fig. 215.

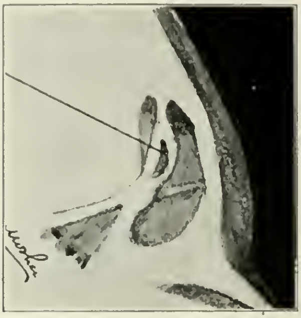

Fig. 216.

Fig. 215.—Lateral *x*-ray Plate (not reduced) Showing Polypi in the Left Frontal Sinus. (Operation performed subsequently, patient of Dr. F. C. Cobb. (Original.)

Fig. 216. *x*-ray Plate (not reduced) Showing an Anterior Ethmoidal Cell Projecting into the Frontal Sinus. (Original.)

The manner in which the plates give the information just detailed is best seen by a careful study of the drawings which are given here. (Figs. 199–216 inclusive.) Some of the drawings were traced from the film side of the plate, and some from the reverse side. It is for this reason that "right" and "left," on the series of drawings, change from side to side.

SURGICAL DISEASES AND WOUNDS OF THE MOUTH, TONGUE, AND SALIVARY GLANDS.

By GEORGE E. ARMSTRONG, M.D., Montreal, Canada.

I. THE MOUTH.

Simple Stomatitis.—Stomatitis, or inflammation of the mucous membrane of the mouth, occurs more frequently in children, but it is also sometimes observed in adults and in elderly people who are subjects of diabetes or Bright's disease.

Catarrhal stomatitis occurs in children debilitated by measles or other exanthemata, and it also follows injuries from jagged teeth or from operations on the mouth. Indigestion and improper feeding are predisposing factors. The mucous membrane, when thus inflamed, is red, hyperæmic, swollen, and tender. The tenderness is specially noticed when food is taken.

Treatment.—In general, improve the hygienic surroundings and nutrition; locally, a mild mouth wash, such as boro-glyceride (1 in 20), should be used. Potassium chlorate, with a little diluted hydrochloric acid, is useful both locally and internally.

Ulcerative Stomatitis.—There is a mild, aphthous form of stomatitis, common in children, in which small round ulcers appear on the tongue and on the mucous membrane of the mouth. Two or more may run together and form an ulcer of some size. The little ulcers are very tender and cause a great deal of suffering, both in children and in adults. They are an evidence of malnutrition, and call for general improvement of surroundings and attention to the patient's diet. The pain is relieved very quickly by touching the ulcers with a bit of cotton wound on the end of a little stick and dipped in a solution of silver nitrate, from thirty to sixty grains to the ounce of distilled water. A little boracic acid, or borax and honey, gives relief, but not so quickly. In adults, a tonic containing arsenic is sometimes effective in preventing recurrence.

The condition generally indicated by the term "ulcerative stomatitis," however, is one of great severity. It occurs in epidemics among the children of the poor in large cities and in orphan asylums. It begins as an acute inflammation of the gums, often starting opposite to a canine and spreading forward alongside the incisors and backward along the molars, and is exceedingly painful. It is usually confined to one side, and is never present before dentition, nor at a point where the teeth are absent, and it seldom occurs after the tenth year. The process may extend to the mucous membrane of the cheek, lips, and tongue. The gums are soft and bleed easily, and the teeth may be loosened. Ulcers form alongside the teeth; they are covered with a dirty, diptheritic-like exudate. The taking of food by the mouth is very painful. There is more or less salivation; the breath is offensive; and the little patients soon become septic. Krauss has described cases in which there had formed, over the ulcers, a slough that required five or six days for complete separation. The disease is undoubtedly infectious, but its contagiousness has not yet been proven. It may continue for a few days only or for several weeks.

TREATMENT.—Above all things, these children should be given the best available hygienic surroundings. Those in the overcrowded districts of large cities are greatly benefited by spending a week or two in the country. The food should be bland and unirritating. The ulcerated areas may be brushed over with a solution of some analgesic, such as stovain or eucain, to permit food being taken without pain. Locally, the mouth may be cleansed, as well as may be, by brushing over the ulcerated areas with a weak solution of carbolic acid (1 to 100), a solution of boracic acid, or a ten-per-cent solution of hydrogen dioxide. Internally, suitable tonics should be administered. Potassium chlorate in rather full doses, according to the age of the child, may be given for a period of three days, but not for a longer time.

It would hardly be possible to confuse the above condition with the patches that resemble curdled milk and that are due to the presence of the parasitic fungus—the "Oïdium albicans"—that is seen in thrush.

Gangrenous Stomatitis; Cancrum Oris.—Gangrenous stomatitis is an infectious, gangrenous, destructive process, beginning generally on the inside of the cheek, and sometimes extending to the bones of the face, the tongue, palate, and fauces. A similar process has been seen on the anal mucosa and on the vulva. It is confined for the most part to children, from two to twelve years of age, who live in the squalid, overpopulated districts of large cities. The patients are generally debilitated, and may be recovering from some of the exanthemata, particularly measles or typhus, or be suffering from mercurial or one of the other forms of stomatitis. It cannot be proven that the disease is due to any single or special organism, but probably the Streptococcus pyogenes and other saprophytic bacilli are the active agents. There is first an inflammatory area, an abrasion or a pustule, on the inside of the cheek. A pultaceous slough forms, with a surrounding infiltrated area. The cheek swells, but there is no œdema in the usual sense of the term. The affected part feels hard. There is surprisingly little tenderness. Then there appears externally a bluish area which gradually becomes black. The area of blackness extends, and there may gradually develop a most extensive œdema over the side of the face, the temple, and the neck. The skin over the affected part of the cheek may slough out. In the worst cases the disease extends to the jaw, the teeth are loosened, and the bones of the face may be invaded and die. The horror and offensiveness of the process reach their maximum when the fauces are involved. The patient is then unable to clear the throat, and cannot swallow; in a word, his condition is most pitiable. Early perforation of the cheek is said to be favorable. If the child survives, the slough separates, and the healing may be followed by contraction of the mouth and cheek, with fixation of the tongue and lower jaw. (See Fig. 155 on p. 436, Vol. V.)

The mortality is high, death resulting from an inspiration-pneumonia or from a septic diarrhœa due to swallowing the foul secretions. In other cases death results from heart failure, or may be due to inanition followed by collapse and coma.

Treatment.—Although the prognosis is exceedingly grave, the condition is not utterly hopeless. Treatment, however, to be effective, must be instituted early and be radical in character. The patient having been brought under the influence of a general anæsthetic, the sloughing area should be destroyed. Some recommend that the slough be removed by a knife or sharp curette. The use of these instruments, however, causes more or less hemorrhage, and, what is still more objectionable, opens up blood- and lymph-vessels and tissue spaces, through which more poison may enter and thus cause a spreading of the infection. If the area is accessible, nothing can be more thorough and rapid in its action than the thermo-cautery. The writer of the article on this subject in Bergmann's "System," noting that early perforation of the cheek is usually followed by a favorable issue, advises that this be done as a detail of the treatment, and that a considerable area of the mucous membrane be destroyed. If no thermo-cautery is available, or if the area is not easily accessible, an application may be made of pure carbolic acid, to be followed by one of alcohol alone, or of a solution of zinc chloride. In extreme cases, loose teeth and pieces of dead bone should be removed, and the exposed surface should be wiped with alcohol. Mouth washes—such as diluted solutions of hydrogen dioxide, of potassium permanganate, or of potassium chlorate, to which a little dilute hydrochloric acid has been added—should be used in as thorough a manner as possible. Feeding is an important detail in the treatment. After the sloughs have separated, the subsequent contractions may require plastic operations to overcome the resulting deformity.

Meloplasty.—Meloplasty will be referred to here only in a very brief manner. (For additional details the reader is referred to the article on "Plastic Surgery" in Vol. IV.) Plastic repair of the cheek is demanded for the relief of conspicuous deformity, but more especially for the removal of hindrances to the free movement of the lower jaw, the result of the preëxisting noma. If the skin alone is involved, the problem is simple; the defect may be repaired by the introduction of a graft removed from some other part of the body—as, for instance, from the inner side of the thigh, according to Krause's method. Further scarring of the face or neck will thus be avoided. When the mucous membrane alone is involved, the skin being intact, the problem is much more difficult. If the defect is small, the scar tissue may be removed, and flaps of mucous membrane, sufficiently mobilized, be brought together to complete the lining of the cheek. If this prove to be impracticable, one may obtain an epidermal lining by inverting into the mouth a flap of cutaneous tissue. Various procedures have been suggested for the accomplishment of this object. It must be remembered, however, that the skin flaps are prone to contract; and, consequently, in shaping them one must allow for contraction to the extent of one-third. Thus, if a flap is to be two inches long, its length, when first cut, should be three inches. In the next place, if a flap containing hairs is turned in, these hairs will continue to grow in the mouth for many years, to the great annoyance of the patient. Another essential to success is to secure perfect access to the field of operation, in order that the flap may be inserted and that the edges of the wound may be accurately coaptated and carefully sutured in position. Gersuny's method has received the approval of von Hacker and von Eiselsberg. (See page 640, Vol. IV.) In this operation a vertical incision is made from the angle of the mouth to the lower border of the jaw, and carried along the latter to within an inch of the angle. The cheek may then be turned up, and the scar tissue removed, care being taken to avoid, if possible, any interference with the opening of Stenson's duct. If this is found to be impossible, a new opening should be provided. A flap of sufficient size is then turned up from the side of the neck. It is completely divided at its circumference, remaining attached by a pedicle composed of subcutaneous tissue and the turned-up edge of the periosteum of the jaw. This flap is carefully sutured in position, the cheek is brought back to its proper place, and the wound in the neck is closed, in the same manner as after the removal of enlarged lymph nodes. The vitality of a flap thus formed is low, and its life uncertain. In men it is desirable, if possible, to get the flap from some part upon which hair does not grow—as, for example, from the forehead or the temporal region. There is less danger of failure when the flap is turned in on a pedicle sufficiently broad to insure its nourishment, as practised by Gussenbauer and others. When the defect is complete, requiring repair of both the mucous membrane and the skin, Czerny's method may be adopted. (See page 643, Vol. IV.) He took a flap from the side of the neck, with its base of attachment at or about the zygoma, and of sufficient length to admit of its being folded upon itself, thus bringing the raw surfaces in apposition and exposing an epithelial surface to the secretions of the mouth. After this has been accomplished it will only be necessary—and probably not in all cases—to complete the angle of the mouth by giving it a mucous lining. The flap described above consists of skin and platysma. If a flap of sufficient length to permit of doubling cannot be obtained, one sufficiently large to close the opening may be secured from the side of the neck or the temporal region; and after the pedicle has been divided, three or four weeks later, the outer surface may be freshened with a Volkmann's spoon, and a Krause graft applied over its surface, care being taken to have the flap free from fat. The surfaces should be perfectly dry, without blood-clots. Very few retaining sutures suffice, as the flap is readily maintained in position by the dressings.

II. THE TONGUE.

Anatomical and Physiological Considerations.—It is rather out of place here to go fully into the anatomy of the tongue. It is given in all the standard text-books on anatomy. There are a few points, however, which may, perhaps, be mentioned with advantage. All the essentials relating to the development of the tongue are given by Professor His, in his "Anatomy of the Human Embryo." A fibrous septum separates the two halves. The lingual artery, through its branch, the dorsalis linguæ, supplies the substance as well as the dorsum of the tongue. In case of hemorrhage from the deeper portions of the substance of the organ, the lingual artery should be secured at the posterior border of the hyoglossus muscle, before it gives off the dorsalis linguæ.

It is generally stated that the lingual is the nerve of common sensation for the anterior two-thirds of the tongue. It is accompanied by the fibres of the chorda-tympani branch of the facial nerve, and it is doubtless along these fibres that sensations of taste are conveyed to the brain. When the chorda-tympani nerve is touched as it crosses the tympanum, a sensation of taste is experienced, and the sensation of taste in half of the tongue is reported as abolished in some cases of facial paralysis due to the involvement of the aquæductus Fallopii.

Pain in the ear and in the neighborhood of the temporo-maxillary articulation is sometimes complained of in diseases of the tongue, and, *vice versa*, pain in the tongue is complained of when there is irritation in the external auditory meatus.

These phenomena are probably dependent on the fact that a communication exists between the lingual and auriculo-temporal nerves. The posterior third of the tongue, the circumvallate papillæ, the foramen cæcum, and the anterior surface of the epiglottis depend, for common sensation, upon the lingual branches of the glosso-pharyngeal nerve. Disease of the posterior third of the tongue may, through Jacobson's nerve, give rise to pain in the region of the middle ear. It is a matter of some importance to know that fibres from the superior laryngeal nerve are distributed over the base of the tongue and epiglottis. These fibres may explain the occurrence of cough and hiccough in disease at the base of the tongue, and also of the spasm of the glottis which is produced when the base of the tongue is too vigorously depressed. Laborde suggests that the excitation of respiratory movement by rhythmic traction of the tongue may be due to stimulation of the respiratory centre through this nerve. Lepine states that obstinate hiccough has been relieved by traction on the tongue.

The lingual tonsil is an aggregation of lymphoid tissue on each side of the base of the tongue, behind the circumvallate papillæ. The faucial and pharyngeal tonsils complete the ring of lymphoid tissue. Sappey's researches, confirmed by Kuettner, prove that all the lymphatics of the tongue may be injected from any part of the tongue. They converge to the submaxillary and digastric triangles, where they join the deep cervical lymph nodes. (See page 526, Vol. II.) Infection may spread from the jugular group to other groups of cervical lymph nodes and so on to the base of the skull. It is, therefore, possible for the lymphatics on one side of the neck to be affected by disease on the opposite side of the tongue.

Congenital Defects and Abnormalities.—CONGENITAL ABSENCE OF THE TONGUE.—This defect is of extreme rarity. Jussieu, in 1718, reported the case of a young girl, fifteen years of age, in whom the tongue was absent, and he states definitely that she was born with this defect. The tuberculum impar, which is the rudiment of the anterior two-thirds of the tongue, had developed into only a small central nodule. This nodule was under muscular control. The girl could speak very well. She had some difficulty in mastication and in swallowing solid food. Spiller, in 1816, reported a similar case in a new-born infant, in whom there also existed cleft palate.

In the congenital cases, one should look for arrest of development produced by the formation of amniotic bands and adhesions which restrain and interfere with the development of the embryonal fissures. In Ahlfeld's atlas is figured a case which was reported by Welde and which shows the fœtal membranes adhering, not only to the edges of the facial cleft, but also to the tongue.

Defective development may result in a small tongue, sometimes adherent to the floor of the mouth, and more or less fixed. If the tuberculum impar does not develop far enough forward, the projecting tip of the organ will be imperfect and there will be tongue-tie.

Congenital Ankyloglossia (Tongue-tie, Adherent Tongue).—Occasionally at birth the under surface of the tongue is loosely adherent to the floor of the mouth, in the same manner as the mucous membrane of the foreskin is adherent to the glans penis. It may be easily separated by the careful employment of a little force. Cases of complete fusion of the tongue with the floor of the mouth have been reported. The question of tongue-tie is of some importance. Since the time of Celsus, and doubtless before, nurses and mothers have been disposed to regard the new-born infant as the victim of tongue-tie. It has even been suggested that the difficulty in getting the infant to suckle—a difficulty due to various causes—should be ascribed to the too great fixity of the point of the tongue. Physicians and accoucheurs have sometimes yielded to this suggestion on the part of the mother or the nurse. It may be confidently stated, however, that if the tip of the tongue can be brought over the border of the gum, and can be hooked up to touch the roof of the mouth, there is no tongue-tie, and consequently no justification for interference with the frænum in any way. Before operating, one should eliminate any history of hæmophilia.

In those rare cases in which it is advisable to divide the frænum, it may be done by dividing it in the middle with a pair of blunt-pointed scissors, the tip of the tongue being held up by two fingers or by the split end of an ordinary director. If the scissors approach too near to the tongue, the ranine artery or vein may be wounded; and if too near to the floor of the mouth, the sublingual artery in the sublingual gland may be endangered. When the tip of the tongue is forcibly raised, only the thin transparent portion of the frænum should be divided. Fatal hemorrhage has occurred in a number of cases in which this operation was improperly done. The blood generally oozes slowly; some escapes externally, and more goes into the stomach and is vomited or passed in the stools. The division of the frænum is undoubtedly necessary in some infants to enable them to suckle, and also in some adults to enable them to speak distinctly. Makuen has reported three such cases in young people. Sédillot and Doellinger have reported cases in which the development of macroglossia was attributed to cutting the frænum.

Treatment of the Hemorrhage.—If there is only oozing, pressure for a few minutes may be all that is necessary. A few drops of adrenalin solution (1 in 1,000) might be applied. If this application does not succeed, place a pledget of cotton against the frænum and make pressure by grasping the tip of the tongue with a piece of sterile gauze and drawing it forward. If this fails, a whiff of chloroform may be administered, and a ligature passed around the bleeding point; or the ligature may be carried beneath, on a sharp, round, curved needle. The friability of the tissues in infants should be borne in mind.

A case in which the tongue adhered to the palate (superior ankyloglossia) and required separation before the child could swallow, is described by Broca.*

Acquired Ankyloglossia or Tongue-Tie.—This condition may result from gunshot injuries, but it has more frequently followed prolonged ulceration. In some cases, the ulceration has followed a mercurial stomatitis, caused by the excessive and prolonged use of mercury. It has also developed under other conditions, as, for example, in smallpox, in syphilis, after the application of perchloride of mercury in diphtheria, and finally as a result of ulcerative stomatitis. In consequence of these prolonged ulcerations, the tongue has become adherent to the side of the cheek, to the lower lip, or to the hard palate. In one case, the tongue, palate, and pharynx were so united that only an opening one-eighth of an inch in diameter remained immediately dorsal to the tongue. (Butlin. In appropriate cases, division of the tissues at the spot where the adhesions exist has been followed by happy results. Sonnenburg removed a portion of the tongue successfully in one instance.

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* Butlin and Spencer, on "Diseases of the Tongue," London, 1900, p. 32. Butlin regards swallowing of the tongue as a result of the habit, prevalent among physicians and even among midwives, of dividing the frænum; a practice which, fortunately, is much less frequently carried out now than it was formerly.

Acquired Abnormal Mobility of the Tongue.—A series of cases have been reported in which the patient by practice could curl up his tongue behind the soft palate, and wipe the posterior nares and orifices of the Eustachian tubes. This habit and this extraordinary range of motion of the tongue have generally been acquired by people who were sufferers from atrophic rhinitis and pharyngitis, in which affections the accumulation of adhesive muco-purulent matter in the pharyngeal vault is very annoying.

Tongue-swallowing.—Since Petit's paper appeared in 1742, attention has frequently been turned to the obstruction of the laryngeal orifice by the tongue as a cause of death. In two of Petit's cases, the frænum had been divided a few hours before death occurred. He found, on making a *post-mortem* examination, that the tip was turned over upon the dorsum, while the chief mass of the tongue lay back so far as completely to obstruct the entrance to the larynx, thus preventing all access of air. Several writers have reported cases of sinking back of the tongue, followed by symptoms of suffocation.* In some of these cases the child has died suddenly. In others, life has been saved, but only by careful watching; the finger being inserted into the mouth whenever danger symptoms appeared. In children thus affected it is better that they should get their nourishment either from the mother's breast or from a nursing-bottle armed with a suitable nipple. If it be found necessary to employ a spoon, only small quantities of food should be given at a time. Sinking back of the tongue may occur after division of the fibres which attach the geniohyoglossi muscles to the lower jaw.

Cases of extreme length of tongue have been reported. They do not seem to have been attended by any special mechanical inconvenience.

Bifid or Split Tongue.—This peculiar anomaly of the tongue has been observed as a congenital condition. The fissure may occupy only the forepart of the tongue, but occasionally it extends far back toward the root. Bifid tongue is the normal condition in the seal and the raven, and also in reptiles. The bifid tongue seems to perform its functions normally. If the patient desires, and there are no contra-indications, the borders of the fissure may be freshened and held together by sutures. Primary union should be obtained. There is no serious bleeding. The bifid tongue is usually present in cases of agnathia. Bifid tongue is accounted for by an arrest of development of the tuberculum impar and the growing forward of the forked tubercle of the base. (Butlin and Spencer.)

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* Fairbairn (Medical Times, 1845, vol. xii., p. 392) and E. Fletcher Ingals (Archives of Laryngology, ii., p. 131) report instances of retroversion or swallowing of the tongue. Cases are also reported from German medical journals (see American Journal of Obstetrics, 1878, xi., p. 208).

The congenital bifid tongue may be distinguished from the deep furrows sometimes seen in syphilitic glossitis by the facts that the organ is soft in consistency and that the papillæ are present. In the syphilitic tongue there is more or less scarring and sclerosis, and the tongue is dry and glistening. "Lingua plicata aut dissecata" is a congenital condition in which a moderately enlarged tongue is thrown into a number of longitudinal and transverse folds, but yet retains its natural softness and a normal mucous membrane.

Congenitally Enlarged Papillæ.—Butlin and Spencer have met with a case in which there was hypertrophy of certain papillæ all over the papillary aspect of the dorsum of the tongue, and this hypertrophy was characterized by the production of tuft-like growths which did not resemble the usual warty growths, and yet could not well be classed among the tumors of the tongue.

Mutilation of the Tongue.—Mutilation of the tongue by pinching, burning, and cutting was practised in Europe until the eighteenth century, and at a later period still in the East. It was a form of religious persecution.

Wounds.—Wounds of the tongue and oral mucosa are common. The most frequent is that caused by the extraction of teeth. Very serious and extensive lacerations may result from the forcing of the lips and cheeks against the teeth by the fist or other object. The hemorrhage, though free at first, usually ceases spontaneously, unless the labial, sublingual, or other artery is torn, or the patient is affected with hæmophilia. Minor tears heal, as a rule, quickly; and but little trace is left of the accident. Larger tears of the buccal mucous membrane may result from bullet wounds or, in children, from running with a pea-shooter or stick in the mouth and falling, or from fish bones.

These less serious wounds may require a few retaining sutures. The satisfactory manner in which repair takes place is rather surprising to one familiar with the researches of bacteriologists who have cultivated hundreds of colonies of bacteria (100 to 1,200) from a few drops of water which has been used to wash the mouth. A very troublesome phlegmonous inflammation may develop in a finger wounded on a jagged tooth, and yet a tear of the oral mucosa generally heals kindly. Many explanations of this occurrence have been offered. It has been suggested that the mucous membrane possesses a special immunity, and that the secretions of the mouth are antiseptic (which is not proved). This much is apparent, that in most cases there is at first free bleeding, that an oversecretion from the mucous membrane and salivary glands takes place, with frequent expectoration, and that usually the mouth is freely rinsed with water or some mildly antiseptic solution. On the other hand, deep wounds, such as are associated with a fracture of the jaw that communicates with the cavity of the mouth, and which readily afford lodgment to micro-organisms, generally become foul, notwithstanding the adoption of the most careful preventive measures.

The tongue is frequently lacerated by the teeth. The teeth may be broken off by a blow which also drives them into the tongue. Very severe wounds are inflicted by a blow or fall on the lower jaw while the tongue is protruded. Epileptics very often bite their own tongues. In the Museum of the College of Surgeons is the tongue of an epileptic idiot, who bit off the end of his tongue in an epileptic fit. He died from hemorrhage and sloughing, both the main arteries of the part having been divided. The tongue is frequently bitten in puerperal eclampsia. Bullet wounds may sometimes cause great laceration of the tongue. It is also sometimes bitten in tetanus, and torn by the fragments of a broken jaw.

One of the great dangers in wounds of the tongue is hemorrhage. If the patient is a hæmophiliac, the danger is all the greater. The blood escapes by the mouth, and may also be swallowed or aspirated, more particularly if the patient is stunned by the injuries, or faints. Infiltration of the soft tissues with blood may occur, and a considerable hæmatoma develop. Butlin and Spencer report two fatal cases of wounds of the tongue and, through it, of the internal carotid and internal jugular. In the first of these cases the patient was smoking, and the elbow of a companion struck the bowl of his pipe, driving the stem into his tongue and causing it to break off about three inches from the end. No bleeding occurred at the time. Three days later, he applied for admission to Guy's Hospital for increased swelling of the tongue, which impaired speech and swallowing. On the sixth day he vomited a pint of blood, and this vomiting recurred, so that by the twelfth day he was very anæmic. An examination of the mouth revealed no wound from which the blood might come. The great swelling made it difficult to open the mouth sufficiently to make a satisfactory examination. The man continued to vomit blood, and died on the fifteenth day, after bringing up blood and clots. At the post-mortem examination it was found that the pipe stem had transfixed the tongue from right to left. Both openings had closed, but in the track of the wound within the tongue was a piece of pipe stem two and a half inches in length. In the left side opposite the wound of exit, was a small triangular opening, just behind and below the left tonsil, and from this opening injection material came freely when the carotids were injected. The fluid injected doubtless escaped by way of the internal jugular, as the clinical course of the case indicated, but there was no dissection to clear up the point.

In the second case, a man who was smoking fell, and drove his pipe stem into his tongue. On the fourteenth day he was taken to the London Hospital, with his tongue enormously enlarged. The dresser lanced the tongue, and let out an ounce of pus. As the respiration became increasingly difficult, the attending surgeon was sent for. He probed the abscess cavity and struck the pipe stem, and with a pair of forceps pulled out a piece four inches in length. This was followed by a torrent of blood, and the patient died in less than a minute, in spite of compression of one and then of both carotids. It was found that the pipe stem had entered the right tip of the tongue, had emerged on the opposite side, near to the root, and then, passing near to the left tonsil, had gone completely through the left internal carotid and internal jugular vein.

Avulsion of the Tongue.—Brouardel reports, so far as I know, the only case on record of a patient pulling out her own tongue.[1] In this instance the patient was a woman and was brought by her husband, who was a policeman, to the physician. The woman, who brought her tongue with her in a handkerchief, stated that, during the day, being overcome by a crisis of nerves, accompanied by an intense feeling of suffocation, she plunged her hand into the back of her throat and pulled out her tongue. The bleeding which followed was trifling. On examination, she was found to be anæsthetic; the reflexes of the throat were absent. The tongue was divided neatly behind the papillæ calciformes, just in front of the epiglottis and behind the tonsils. Her speech was fairly intelligible. Mastication was effected with but little difficulty.

TREATMENT.—Treatment of wounds of the tongue may be considered under four heads: Preventive treatment; employment of antiseptics; arrest of the hemorrhage; and management of the wound.

1. *Preventive Treatment.*—This comes into play in epileptic patients. During a convulsive seizure, thrust a piece of wood or a knife handle between the teeth. When the patient is subject to nocturnal seizures and tongue-biting, the wearing at night of an interdental splint has been advised.

2. *Employment of Antiseptics.*—Strong antiseptics have no place in oral surgery, because of their irritating and poisonous qualities. Normal saline solutions alone, or perhaps with the addition of a solution of hydrogen dioxide (in the proportion of twenty-five per cent of the latter) or of a one-per-cent solution of carbolic acid or of a 1 to 10,000 potassium permanganate solution, are safe and useful.

3. *Arrest of the Hemorrhage.*—The oozing from small wounds soon ceases spontaneously, or may be controlled by digital pressure. A piece of sterile gauze, or the same saturated with a solution of adrenalin (1 in 10,000), may be retained in contact with the oozing surface. A retaining suture may be made to do good service in controlling oozing.

4. *Management of the Wound.*—In large wounds the administration of a general anæsthetic is of the greatest service. The tongue can then be pulled forward by tongue forceps, or by long silk sutures passed through the tip. Clots can then be removed, the source of the bleeding determined, and the vessels caught with the forceps and tied with fine catgut; or a firm catgut ligature may be passed around the bleeding-point on a round, curved needle. If free bleeding takes place from a punctured wound of undetermined depth, it is far safer to enlarge the wound and arrest the hemorrhage. In secondary hemorrhage, however, the arrest should be made at a non-infected site. Fortunately, secondary hemorrhage is a rare occurrence. The tissues of the tongue, however, may be

so highly œdematous and so friable that ligatures tear out, or may not be considered reliable. Under such circumstances the lingual, on one or on both sides, should be tied. In rare instances it has been thought necessary similarly to tie the external carotid.

In large wounds approximation of cut surfaces is always desirable. These wounds generally heal kindly, and with remarkably little deformity. Later on, if necessary, a projecting border may be pared down to the level. In old wounds, the exposed surfaces of which may be more or less covered with a growth of epithelium, it is well to freshen the parts before drawing them together by sutures. In cases where the base of the tongue has been extensively lacerated—as, for instance, by a bullet wound—some surgeons have found it advantageous to perform tracheotomy. The pharynx can then be plugged, the blood prevented from entering the air passages, and the distress and danger from swelling and œdema of the glottis obviated during the stage of inflammatory reaction. Fine silver wire, silkworm gut, and horsehair are satisfactory suture materials. In these cases, the formation of an abscess occasionally results.

Foreign Bodies.—Instances are on record in which a foreign body—a small bristle from a tooth brush, a fish bone, the amber mouthpiece of a pipe, a bullet, or a tooth—has remained embedded in the tongue for periods of time varying from a few days to a number of years. In one case a bullet remained six years, during which time the man stammered excessively. The stammering ceased after the bullet was removed. The foreign body may lie so deeply embedded that it cannot be felt, or it may suggest the presence of a new-growth. Usually, sooner or later, a sinus forms and granulations protrude from its orifice. If the sinus does not heal, it is a good rule to suspect a foreign body. Recurring hemorrhage should excite suspicion. Before a foreign body is removed from the tongue, ample preparation should be made to control hemorrhage if it should occur.

Stings of Bees and Wasps, and Bites of Serpents.—Bees and wasps generally gain access to the mouth in food. Snake-charmers have had their tongues bitten by serpents. The traumatism may be considerable, and may, in conjunction with the poison, give rise to alarming symptoms. The tongue may become much swollen, œdema of the glottis may follow, and the question of tracheotomy will arise for consideration. Incisions are seldom required; the subsequent formation of an abscess is a rare occurrence. Local thickening around the little wound may persist for some time. F. Clark recommends the employment of an alkaline mouth wash, and for this purpose he prefers a weak solution of ammonia. Butlin suggests the injection of a weak solution of ammonia into the site of the sting. Faintness and collapse would require active and appropriate treatment.

Burns and Scalds.—In adults, the tongue most frequently suffers from hot food or hot drinks, from smoking a hot pipe with a short stem, or from accidentally putting the lighted end of a cigar into the mouth. In children, the accident results from too hot food, but it occurs more especially among the children of the poor, and particularly in older countries, where one utensil—as, for instance, the tea-kettle—is misused. A child may think that the kettle contains cold water, when it really contains hot water, and, in attempting to drink from the spout, gets scalded. Thus, steam from boiling water may be forced into the mouth and be inhaled into the pharynx, larynx, and trachea. If it comes in force, it may produce, not only a scald, but also a certain degree of distention of the parts. In the mildest cases, the scald presents simply a shining, smooth red surface. Blisters may form on the surface of the tongue and on the buccal mucosa. An ulcerated surface may remain for a long time. The real danger lies in the extension of the burn or scald to the epiglottis, the arytenoid folds, and the mucous membrane of the larynx, trachea, and pharynx.

Burns also result from the accidental or intentional swallowing of strong caustic acids and corrosive poisons. A woman in London bought a half-pennyworth of gunpowder, put it into her mouth, and ignited it, causing blood to ooze from the mouth, and burning the tongue and the roof of her mouth. She was taken to St. Bartholomew's Hospital and died on the following day. (Butlin.)

An infant sometimes puts an acid or a strong lye into the mouth. Sulphuric acid produces a black scar; nitric acid, a yellow; carbolic, a white and hard scar. Corrosive sublimate produces a white and shrivelled tongue. Deep sloughs often follow, which separate slowly and leave ulcerated areas that tend to contract or form adhesions with other adjacent ulcerated areas.

The first symptom is, of course, pain. In slight burns this soon passes away; in those of a more severe character the taking of any kind of food for twelve or twenty-four hours will be painful. Locally, there may be observed simply a reddened smooth patch. In the more serious forms, bleeding, discolored areas, and œdema are present.

Treatment.—The pain may be relieved in children by a mouth wash composed of borax and honey or consisting of a weak solution of potassium chlorate, by sucking ice, or by the application of cocaine to the burned area. Chemical antidotes are always in order. Swelling and œdema may be lessened by the constant sucking of ice and by the application, externally, of an ice bag or an ice-water coil. A mouth wash of boracic acid or of a one-per-cent solution of carbolic acid will be found useful. If œdema of the glottis develops and interferes with respiration, tracheotomy should be performed early. Pitt found this necessary in twenty-three out of seventy-seven cases of burns in children. It is particularly urgent in patients with marked renal insufficiency.

Glossitis.—Glossitis, or inflammation of the tongue, occurs in a variety of forms; at one time involving only the superficial layer, at another the deeper substance of the tongue. Sometimes only one half, and at other times both sides are attacked. The disease may run a rapid and virulent course, or it may assume the characteristics of a chronic affection.

Hemiglossitis is usually of a somewhat mild character. The left half is more frequently involved than the right. The disease may not extend much below the surface, but generally there is a palpable lump in the substance of the tongue. Guterbock has described a series of cases of hemiglossitis, which he thinks are of a nervous origin. The attacks come on suddenly, are quite painful, and are characterized by fever and by the production of vesicles over one half of the tongue. There may also be enlargement of that half. Guterbock thinks that in these cases the attacks are secondary to some affection of the lingual branch of the fifth nerve. There can scarcely be any doubt with regard to their relationship to herpes. Butlin reports a case that was associated with paralysis of the seventh nerve. In this case, the chorda tympani may have been involved. Resolution generally takes place rapidly and leaves the parts in a natural condition, although a hard lump has been known to remain for some months.

A laxative may be indicated. Scarifications are seldom required. Local applications of iced or of hot water, followed by an astringent mouth wash, will sometimes prove useful. In cases of nervous origin, the treatment should be directed to the nerve lesion.

Superficial glossitis might, perhaps, with more propriety be considered by the physician. The superficial layer of the tongue is alone involved; there is desquamation of the filiform papillæ. The condition is associated with debility; in children it results in the so-called "geographical tongue" or "wandering rash." Itching is sometimes complained of. In adults a raw, smooth tongue is usually associated with dyspepsia. Fissures and furrows are of relatively small interest. A furrow down the centre of the tongue is not uncommon, and may be without pathological signification. There may also be other furrows, most of them running in a longitudinal direction. These natural furrows are not raw. When the edges are separated, they are seen to be covered with epithelium. The long deep fissures which are generally located along the border of the tongue may occur as a late secondary manifestation of syphilis, but usually they represent a tertiary lesion.

Treatment.—In children, the "wandering rash" calls for improved hygienic surroundings and improved nutrition. Collier[2] found that some benefit followed the local application of a fairly strong solution of chromic acid (one drachm to one ounce of water). The subsequent restoration of nasal breathing was followed by appreciable improvement in the condition of the tongue, the rings becoming less numerous and less tender.

In adults the raw dyspeptic tongue may be relieved by the employment of a wash of potassium chlorate. The chief indication, however, is to overcome the indigestion. The deep furrows in the tongue cannot be removed altogether. That condition, however, may be greatly improved by the use of a cleansing antiseptic lotion. The furrows may be painted night and morning with a solution of perchloride of mercury (1 in 1,000), the mouth immediately afterward being thoroughly rinsed with water.

Koenig reports a case of primary diphtheria of the tongue following an operation on the mouth.

Herpes of the Tongue.—This affection of the tongue, sometimes called "hydra," presents very much the same characteristics as it does when the skin is the part involved—*i.e.*, there are vesicles resting on an inflamed base. The vesicles may form pustules, and these in due time undergo desiccation, peel off, and leave ulcers. In true herpes of the tongue there is no swelling of the organ as in hemiglossitis. The condition should not be confused with aphthous ulcer, or thrush. It occurs in nervous individuals, and has followed exposure to cold. It has also developed in the course of an attack of syphilis.

TREATMENT.—Dietetic, hygienic, and general therapeutic indications should be met. Hutchinson recommended the use of arsenic. Butlin and Spencer have seen greater benefit follow the use of antiseptics locally. Butlin speaks highly of the use of ointments—as, for instance, one containing 4 or 5 grains of cocaine, 10 grains of boracic acid, 2 drachms of vaseline, and 6 drachms of lanolin. After the tongue has been thoroughly dried a small lump of the ointment should be placed upon it, and rubbed in by pressing the tongue against the roof of the mouth and the inside of the cheeks and gums. This is to be done several times in the twenty-four hours.

Chronic Superficial Glossitis; Leucoma.—This affection is characterized by the transformation of the superficial epithelial layer of the tongue into horny tissue—a process which may be termed a keratosis. It is known by several names: leucoma (Hutchinson), leucoplakia (Schwimmer), and psoriasis (Hulke). As Butlin points out, a more strictly correct name would be leucokeratosis. Small patches of keratosis are generally known as "smokers' patches." The term "psoriasis" may quite properly be reserved for scaly patches occurring on the tongue in patients suffering from simple psoriasis or from a scaly syphilide, and the term ichthyosis, suggested by Hulke, for advanced stages in which there are hard and warty areas. The affection possesses increased interest from its recognized tendency to develop into epithelioma. The histology of this condition has been studied and described by Sangster, Leclair, and Butlin. There is a proliferation of the superficial cells, leucocytes collect, and scar tissue forms immediately below the epithelial layer. In some instances the cells of the granular layer become vacuolated and show granules of eleidin. This is a change similar to that which is seen so abundantly in the cells of the epithelioma. It is looked upon as a degenerative process, a dekeratinization, and also as a stage immediately preceding the time when the epithelial cells, ceasing to grow upward, will, as it were, turn about and form downward growths of epithelium—growths which mark the beginning of cancer. (Butlin and Spencer.[3, 4])

Pathological Changes.—Patches of leucoplakia are observed on the surface of the tongue and on the inner side of the cheeks and the lips. They present an opaque, bluish-white appearance, and are characterized by the absence of the normal papillæ of the skin. On the tongue, the patches may extend until the whole dorsum in front of the circumvallate papillæ is covered. The layer is sometimes exceedingly thin and soft to the touch, and does not appreciably interfere with the movements of the tongue or lips. In more advanced cases these patches feel tough and horny, and the tongue is somewhat less flexible than normal. In these cases the patches are furrowed, and the fissures may be ulcerated. The borders and under surface of the tongue are sometimes involved.

Symptoms.—In the majority of cases the patient feels no inconvenience, and the patches are discovered accidentally by himself, his dentist, or his physician. Later on, a smarting is felt, after an evening of excessive smoking and drinking, and again on the following morning. Later still, hot and highly seasoned food causes burning and smarting. In extreme cases, chewing and even speech may be so painful that it has been found necessary to employ cocaine in order to secure relief. Nedapil regards leucoplakia as essentially a chronic inflammation. It is to the researches of Nedapil and Schuchardt that we owe most of our knowledge of the relations of leucoplakia to epithelioma. These investigators have shown that while, as a rule, there is simply an increased deposit and cornification of the epithelium, yet in many cases there are, in addition, such changes as hypertrophy and hyperplasia of the papillæ, the formation of new blood-vessels, and an infiltration of leucocytes in the subepithelial layers.

As illustrating the changes that may occur in the progress of the disease, Salomon and Papin report a case which, in 1863, presented merely very small ulcerations of an aphthous character on the surface of the tongue. In 1871 a little plaque, the size of a lentil, was situated on the anterior part of the dorsal surface of the tongue. In 1881, removal by operation was done by Professor Richet. The growth recurred and was removed by operation on four subsequent occasions, *viz.*, in 1887, 1894, 1898, and again in 1900.

Etiology.—Leucoplakia would seem to have both a predisposing and an exciting cause. Its frequent occurrence in smokers has given rise to the name of "smokers' patch." Ludwig has demonstrated the presence of carbolic acid in tobacco-smoke, and this discovery has suggested the idea that carbolic acid produces the patch, as it does when applied to the skin. No one has yet definitely differentiated "smokers' patch" from a leucoma in a non-smoker. While it is true that leucoplakia occurs most frequently in smokers, it undoubtedly occurs in those who have never smoked and never had syphilis. In Schougarth's series of 596 cases, only 28 were in women. Some women in whom patches of leucoplakia have been observed have been smokers. The fact that leucoplakia occurs more frequently in men than in women is accounted for by the fact that men more generally smoke and chew tobacco, and take undiluted spirits. Schougarth estimates that sixty-five per cent of patients suffering from leucoplakia are syphilitic. On the other hand, Schwimmer observed a primary syphilitic infection in a man who had a well-developed leucoplakia patch. Of 324 cases of leucoplakia collected by Fournier 259 were syphilitic, and in the remaining 65 syphilis was excluded. Antisyphilitic remedies have not been found effective in the treatment of leucoplakia. Butlin has observed a patch of leucoplakia on the vulva, and he thinks that gout and rheumatism may be etiological factors. He also thinks that vulcanite plates may tend to develop the disease. It is quite clear that thousands of men do smoke, and smoke heavily for years, and that many people of both sexes have gout and rheumatism, wear vulcanite plates, and suffer from syphilis, without developing leucoplakia. It seems obvious, then, that there must be some predisposition, some peculiarity of the mucous membrane, that renders it easily affected by mild irritation. The disease, according to Spencer,[4] is seldom observed under twenty or after sixty. The same authority points out that the epithelium of some persons appears to be peculiarly susceptible to the influence of tobacco, whether smoked through a pipe, cigar, or cigarette, or simply chewed. The irritative effect is greater when the tobacco acts on some chance sore or syphilitic inflammatory patch. On the other hand, snuff does not give rise to irritation; in spite of the universal use of snuff in the eighteenth century, no mention is made of any ill results to the nose.

Hake has shown that when tobacco undergoes combustion the greater part of the nicotine is converted into pyridine and its compounds; but not all the nicotine so disappears, for as much as one-seventh of the amount has been recovered from the smoke. In pipe-smoke pyridine is the chief constituent, in cigar-smoke trimethyl pyridine or collidin. When tobacco is chewed, a part of the nicotine is decomposed with the formation of pyridine by the action of warm caustic potash, and it is therefore possible that pyridine may be formed in the mouth by the action of the saliva. Pyridine is a base, and may combine with fatty acids or with alkaline salts such as potassium carbonate. The harmless character of snuff may be due to the small percentage of nicotine, the relative absence of pyridine, the greater length of time allowed for fermentation, or the larger addition of alkaline salts. This may serve as a guide when the attempt is made to distinguish different kinds of tobacco; for the percentage of nicotine varies in these different kinds, just as that of alcohol does in different wines. Virginian tobacco, for example, contains from six per cent to eight per cent of nicotine, whereas Havana tobacco (as well as snuff) contains only two per cent. Workers in gas-tar, paraffin, and carbolic-acid manufactories suffer from similar irritation, which may ultimately develop into cancer.

Spencer says that the influence of tobacco on the mucous membrane of the mouth and tongue appears clinically under two forms: (1) as an excoriation—a certain area becomes painful, the epithelium covering it then becomes detached, and there is left a raw surface with red papillæ; (2) as a superficial glossitis, which causes the papillæ to disappear and leaves a patch of inflammatory tissue over which extends a thin layer of glazed epithelium. The chronic form of glossitis, on the other hand, causes a marked thickening of the superficial layers of the epithelium, which presents the appearance of a whitish, raised patch, comparable to the epidermis of the palm. To this latter condition various names, such as leucokeratosis, leucoplakia, and psoriasis have been attached. In a horny or warty patch of heaped-up epidermis, the papillæ are markedly elongated upward, and the interpapillary masses of epithelium project downward in the form of inverted processes. These changes in the epidermis are accompanied by the aggregation of small round cells beneath the epithelium, and this aggregation produces clinically a slight degree of induration. Well-marked induration of the base of the patch or the commencement of ulceration indicates the development of epithelioma, and this is almost certain to follow the formation of the horny or warty patch. When once it is decided, in a given case, that tobacco is the cause of these irritations, its use in any form should be stopped absolutely, and should be resumed only after a rapid and entire disappearance of the affection. Caustics and the cautery should never be applied. Benefit may be derived from alkaline mouth washes, from the application of lotio nigra or a weak solution of potassium bichromate (five to ten per cent), or from the use of unguentum hydrargyri. In conclusion, Spencer commends Butlin's advice: that the patches be excised, and the edges of the wound brought together by suture (unless after ten days of treatment there is much improvement) as the most certain way of preventing cancer.

Diagnosis.—The thin white or bluish patch of leucoplakia, often so thin that the red tongue shows through, is generally easily recognized. It may be confounded with syphilitic mucous patches. Mucous patches develop quickly, while leucoplakia requires considerable time for its development. Mucous patches are yellowish-white and slightly raised, and they generally occupy the borders of the tongue. Leucoplakia is bluish-white, flat, and occupies, as a rule, the centre of the tongue. Mucous patches are generally associated with secondary lesions on the skin and enlarged cervical lymph nodes. The lymph nodes are not enlarged in leucoplakia. Then, again, mucous patches on the tongue are often accompanied by similar patches on the pharyngeal tonsils. Leucoplakia has never been observed on the tonsils. The scars of secondary syphilitic ulcers on the tongue are bluish-white, but are depressed and remain stationary. They do not spread.

Aphthous ulcers occurring in children are an acute manifestation; they are tender and painful. In beginning epithelioma there is palpable induration. If in serious doubt, the surgeon should remove, with the scissors, a small piece for microscopical examination.

Prognosis.—Leucoplakia, once thoroughly established, can be entirely gotten rid of only in exceptional and early cases. The frequency with which it ultimately develops into carcinoma is difficult to determine. (Fournier says thirty per cent.) Certainly a very considerable percentage of cases of epithelioma of the tongue develop in old leucoplakia patches.

Treatment.—Predisposing and exciting causes should be removed, as far as possible. If a gouty, rheumatic, or uric-acid diathesis is present, an effort should be made to correct it. Butlin would substitute a gold for a vulcanite plate. The teeth should be examined, and all sharp corners removed. The mouth should be kept in the best possible hygienic condition. Smoking and chewing should be prohibited. If the patient refuses, he should be asked to smoke only in the evening, and to smoke very slowly, in order that the smoke may be as cool and unirritating as possible. Irritating and hot foods and liquids should be avoided. Spirits, if taken, should be well diluted. Caustics—nitrate of silver and the actual cautery—should never be applied. A mouth wash of potassium chlorate or potassium bicarbonate (10 grains to the ounce), of listerine well diluted, or of diluted chromic acid (1 or 2 grains to the ounce), is likely to prove beneficial. Butlin speaks highly of ointments applied to the tongue. He believes that they produce a more prolonged action. As a basis, he recommends 2 drachms of vaseline with 6 drachms of lanolin, to which may be added borax, cocaine, eucalyptus, or any indicated drug; and the applications are to be made night and morning. The suggestion of Volkmann to scrape and cauterize the patch is not generally commended. Old thickened corneous patches that are small and single have been excised.

Nigrities Linguæ; Hyperkeratosis Linguæ; Hairy Black Tongue.—The hairy black tongue is a rare condition, in which the filiform papillæ are so hypertrophied and elongated as to resemble hairs or, as in Curtis's case, long tendrils like seaweed. There are no real hairs. The hypertrophy is the main feature, the color being merely a secondary matter. It is generally black, but may be brown, yellow, or blue. Sendziak's patient shaved them off periodically. The color is probably due to the action or presence of a micro-organism. The patch is usually in front of the circumvallate papillæ in the median line. In Curtis's case the patch was behind the circumvallate papillæ. As a rule, there are no subjective symptoms. An unpleasant taste may be present in the morning.

In Johnson's patient,[19] an elderly man, a circumscribed bunch of what seemed to be hairs on the dorsum of the tongue caused a persistent tickling sensation in the roof of the mouth. Johnston also reports a hairy condition of the surface of the tongue in a negro aged thirty-five, who also had a large ulcer on the right tonsil. All over the tongue the filiform papillæ could be raised with the probe until the dorsum resembled the back of a porcupine. The base of each papilla was very thick, and projecting from this was a thin prolongation resembling somewhat a hair in appearance. The black discoloration seemed to be confined to the prolongations, since the thickened bases were of a pale color. After mixed treatment had been carried on for about a week the furred condition of the tongue had entirely disappeared. Dr. R. H. Craig has recently had two well-marked cases of black hairy tongue in his clinic at the Montreal General Hospital. In both cases the black areas cleared up under the use of antiseptic mouth washes rubbed on the tongue by means of a towel. The parasitic theory of Maurice Reynaud, who first observed spores on the lingual vegetations, is not universally admitted. (See Roger and Weil.[8]) The multiplicity of parasites in the mouth and the impossibility of reproducing the lesions always leave a doubt. Lucet isolated a fungus which he called Saccharomyces linguæ pilosæ, and he believed that possibly it might be the cause of black tongue. Roger and Weil by a different technique isolated probably the same fungus, which in culture produced a true mycelium. The patches sometimes disappear spontaneously. They may be mopped with a solution of carbolic or salicylic acid. Apparently the disease does not predispose to carcinoma.

Acute Parenchymatous Glossitis; Phlegmonous Glossitis.—Acute glossitis is a rare disease. In its more severe forms it is most distressing, and is attended by a good deal of danger to life. It develops rapidly, and in from eight to ten hours the tongue may become so swollen that speech is impossible; dysphagia and dyspnœa may also be present. It occurs more frequently in men, particularly in those addicted to the use of beer and spirits and to immoderate smoking; it is more common in winter. The tongue may quickly become so much enlarged that it presses against the teeth; it may also partly protrude from the mouth or may push up the soft palate and be accompanied by œdema of the glottis. As a rule, the body temperature is not high. There is considerable salivation. The swelling, pain, and fixity of the tongue are sometimes so great that the patient cannot properly expel the mucus, and under these circumstances inspiration-pneumonia is to be feared. The lymph nodes and salivary glands are enlarged.

Acute glossitis is probably always the result of infection, the intensity of the swelling and the subsequent course of the disease depending upon the variety and virulence of the causative organism and the condition of the patient. The various organisms found in the healthy mouth are, under ordinary circumstances, not effectively pathogenic. The saliva is regarded as protective. Under favorable circumstances, however, these organisms become active and effective. The staphylococci are virulent, and in some cases have been found *(e.g.,* by Spencer) in the scrapings from the throat and in the swollen glands. Staphylococci are associated more commonly with circumscribed inflammation and abscess-formation.

Erysipelas may invade the mouth and involve the superficial layers of the tongue, or even, in rare instances, the deeper tissues, causing great swelling and œdema of the glottis. If, among the infective organisms, the streptococci predominate, one would expect a more intense inflammation than if the staphylococci predominated. Infectious conditions spread from the palatal to the lingual tonsils more frequently than is generally recognized. In the severe cases the infection may extend to the neck, and give rise to Ludwig's angina, so called from the fact that the disease was first described by Ludwig, of Stuttgart, in 1836.

Diagnosis.—The diagnosis is generally obvious. As considerable swelling sometimes results from the presence of salivary calculi, it is advisable to examine first the floor of the mouth before a definitive diagnosis is made.

Treatment.—Mild cases yield rapidly to a brisk purge, the use of an antiseptic mouth wash, and sucking of ice. The severe cases develop quickly, and almost from the first they are a source of keen anxiety to patient and physician. The danger is from toxæmia, and also, to a still greater degree, as before mentioned, from dyspnœa, dysphagia, and inspiration-pneumonia due to the difficulty of clearing the throat of mucus. In cities the severe cases can be cared for with a greater degree of safety in hospitals, where skilled assistants and hospital resources are immediately available at any hour of the day or night. In such cases no food should be given by the mouth. If the symptoms become distressing from the great swelling of the tongue, free incisions generally give prompt relief and should be resorted to early. An incision should be made on each side of the median line, two inches long, and one-quarter to one-half inch deep. The rather free bleeding gives relief and generally stops in a short time. The tension is relieved, opportunity is afforded for the exudation of serum, and resolution generally takes place rapidly and in a satisfactory manner.

If the swelling extends down the neck, and Ludwig's angina develops, free incisions should be made over the swelling; they should extend through the superficial and, in phlegmonous cases, through the deep fascia. If there be œdema glottidis tracheotomy should be performed without delay.

The incisions seem to inhibit abscess-formation. Should deep suppuration, however, occur, the pus must be evacuated, preferably by making a superficial incision, and then endeavoring, by means of a director, to reach the collection of pus. If this prove successful, the opening thus established may be dilated by forceps.

Gangrene of the Tongue.—Gangrene of the tongue, with sloughing and loss of the greater portion of the organ, is fortunately an infrequent occurrence. It has followed acute glossitis, compression of the blood-vessels, inflamed ulcer, malaria, smallpox, syphilis, and anthrax. But little can be done to limit the destruction of tissue. Potassium chlorate and antiseptic mouth washes may be used. In malaria quinine, and in syphilis potassium iodide may be of service.

Mercurial Glossitis.—Mercurial glossitis is now largely a thing of the past. The drug is administered at the present time in smaller doses and with greater care than formerly, and workers in mercury are more carefully protected. In a mild form it is occasionally seen in patients of low vitality and unusual susceptibility. The condition is readily recognized by the accompanying fœtid breath, spongy and tender gums, loose teeth, and profuse salivation. It subsides promptly on withholding the mercury. The use of a mouth wash of potassium chlorate, alum, or perchloride of iron, and the administration of a saline purgative and a suitable tonic are additional useful measures. A process resembling phagedæna has been described.

Epizootic Stomatitis (Hoof-and-Mouth Disease of Animals).—Our knowledge of this disease in man is derived chiefly from the published researches of Siegel, of Berlin, although the condition was recognized in man by Sagar in 1765. Siegel studied an epidemic of aphthous stomatitis which occurred, in the vicinity of Berlin, in children and adults. It was confined to sections of the city in which the inhabitants received their supplies of milk from cows suffering from epizoötic hoof-and-mouth disease. Vesicles appeared on the surface of the tongue and the inside of the cheeks and lips, and occasionally on the mucous membrane of the pharynx and nose. Vesicles were also observed on the prepuce and vulva, on the extremities, and on the fingers about the base of the nails. In severe cases the vesicles of the tongue were followed by ulcers. Although the tongue was sometimes greatly swollen, suppuration did not occur. Fever was present, and also more or less gastro-enteritis. In some cases an urticarial rash was observed on the body, and in a few instances there were petechiæ. Ludwig's angina, which was attributed by Sujet to the invasion of the vesicles or ulcerated areas by streptococci, was also an occasianal occurrence. Sujet found in the vesicles a bacillus which, when injected into the pharynx of a calf, produced the disease. The same bacillus was found in the stools and in the liver and kidneys of men and animals dying of the disease. Hertwig and two assistants swallowed milk from an infected cow and suffered from the disease. Of six patients, two died of sepsis. One of the four who recovered had gangrene of the tongue, thought to be secondary to pressure by the teeth while the tongue was in a swollen condition.

The diagnosis, in cases of this nature, would depend chiefly upon the simultaneous association of the condition in man and in cows.

Actinomycosis.—The entry of the actinomycosis fungus into the body takes place commonly through the mucous membrane of the mouth and throat. It may be carried beneath the mucous membrane on a fragment of grain or a piece of grass or wood. Once embedded beneath the mucous membrane, it begins to develop. The growth is usually slow, occupying months or years, but in some cases its progress is more rapid. It may penetrate the muscles, and may extend down the neck. Trismus is common in the cervico-facial forms. Small abscesses form and discharge, leaving funnel-shaped sinuses. In Illich's series of 392 cases, it was primary in the tongue in 16, and in the mouth in 234. It may enter the ulcerated surface caused by the sharp corner of a carious tooth. The inflammatory nodule is common in the tongue. It varies in size from that of a bean to that of an egg. After the lapse of months or years it softens in the centre and becomes indistinctly fluctuating; yellowish gritty particles may be seen in the collection of pus. The diagnosis is confirmed by the finding of the ray fungus with the microscope. (See also page 56, Vol. II.)

Treatment consists in laying open the sinuses, removing all the infiltrated tissue by means of the knife and curette, and cauterizing the surface with the actual cautery or with carbolic acid. Affected nodes should be excised, and the edges of the wound sutured. The internal administration of potassium iodide has been recommended, but the value of the drug in this disease has not yet been established. When the foci are once thoroughly removed, a favorable prognosis may be made.

Animal Parasites.—Three cases of Guinea worm in the tongue have been reported, two by Cezilly[26] in 1858 and one by Hillier in 1892. In these cases the symptoms were those of local glossitis, limited to the under surface and tip of the tongue, and terminating in the formation of an abscess. The gums were swollen and tender and bled easily, and salivation was present. In Hillier's case a Guinea worm three feet long was removed from the abscess cavity. The worm probably effected an entrance by way of one of the salivary ducts.

TRICHINA SPIRALIS.—Trichina spiralis occurs in the muscles of the tongue, just as it does in the voluntary muscles in other parts of the body. If it were to occur primarily in the tongue and remain limited to that part—as actually seems to have happened in the case observed by Miller—the diagnosis would be difficult. The swelling is considerable, and the tongue looks as if it were the seat of a simple, non-parasitic glossitis. If the disease should be limited to the tongue, excision would be indicated.

Leprosy.—In cases of leprosy, lesions similar to those on the skin may appear on the tongue. Campana saw, in a leper boy, a group of small papilliform tumors that formed an oval plaque as large as a twenty-five-cent silver piece, slightly elevated, and with a rough surface. Some of the separate tumors were rounded in form, and some were conical. They were of a rose color, and painless. The characteristic bacilli were found in one which was removed and examined microscopically. A section through a leprous tongue showed bacilli collected in groups and in ball-like masses. Injections of lepralin have proved useful in cases of moderate severity. (E. R. Rost.[5])

Echinococcus or Hydatid Cysts.—Cysts of the Cysticercus cellulosæ are sometimes found in the floor of the mouth. They may be confused with ranula. They are firm, freely movable, and spherical. They are always multiple, and may be found at the same time on other parts of the body. They are to be distinguished by their contents. They are easily removed under cocaine.

Non-parasitic Cysts of the Tongue and Mouth.—Mucous cysts occur on the inside of the cheeks and lips, and less frequently on the sides and under surface of the tongue. They are retention cysts, and vary in size. Generally they are about the size of a filbert. They often have a bluish tinge, and the contents are a thin mucous or colloid material derived from mucous glands. They are painless, and cause annoyance only by their size. They may be caught between the teeth during mastication, and bruised or ruptured. They may be shelled out, or the projecting sac wall may be caught by a pair of tissue forceps and cut away with the scissors, the remaining base being removed by curetting or by means of the cautery. A retention cyst arising from one of the glands of Nuhn at the tip of the tongue may develop to the size of a walnut.

The cysts which are occasionally found at the base of the tongue develop from the remains of the lingual part of the thyroglossal duct, near the foramen caecum, or from some of the mucous glands which open between the circumvallate papillæ. These glands have a long excretory duct, and the cysts are sometimes deeply situated. They cause irritation and cough by pressing on the epiglottis.

Blood Cysts.—Cysts containing blood are rare. They have been observed in connection with degenerating naevoid tumors on the front and at the back of the tongue, and they are sometimes associated with cysts and tumors in and about the thyroglossal tract. They may be incised and allowed to granulate. Any tendency to bleeding may be checked by packing with gauze dipped in a solution of adrenalin 1 in 10,000.

Chronic Abscess.—Chronic abscess is occasionaly encountered under the mucous membrane of the dorsum of the tongue. It is generally secondary to traumatism, syphilis, or tuberculosis. It is circumscribed, less prominent than a cyst, not painful or tender, and usually situated in front of the circumvallate papillæ. Fluctuation may be present, or else it cannot be detected because of the tenseness of the abscess. In doubtful cases the diagnosis may be cleared up by inserting an exploring needle. These abscesses usually heal kindly after a free longitudinal incision has been made, and the cavity wiped out with a bit of gauze held in the bite of a pair of tissue forceps. If the abscess be of tuberculous origin, excision of the sac wall may be undertaken in favorable cases.

Lymphangioma.—In addition to the cysts already mentioned, there occur others which vary in size, are lymphatic in origin, and are for the most part congenital. These lymphatic cysts may be large and single, or smaller and multiple. The large cysts are found at the end of the tongue and on the inside of the cheek. The contents are clear and thin, and their nature is disclosed by the microscopical examination of the cyst wall and the endothelial lining. They are often irregular in outline, and the base may be ridged and elevated, due to cystic involvement of the cavernous tissue. A number of small cysts are in other cases found at the base of the tongue, lying upon and between the fungiform papillæ. According to Doellinger, the fungiform papillæ may undergo cystic degeneration.

Lymphangiomatous Macroglossia.—Small vesicles may be seen over a part or the whole of the surface of the tongue. (Fig. 217.) They may be so fine that they can be seen only with the aid of a hand magnifying-glass. In some cases they seem to be only superficial; in others they are more deeply placed, sometimes extending into, and involving the whole thickness of, the tongue. A part or the whole of the organ may be affected. Fine red capillaries are seen running between the vesicles. The contents of the latter are clear when they are filled with lymph, and red or blue when arterial or venous capillaries have ruptured into them. That the enlargement of the tongue is due to the presence of a true cavernous lymphangioma has been shown by O. Weber, Virchow, Maas, and Wegner.

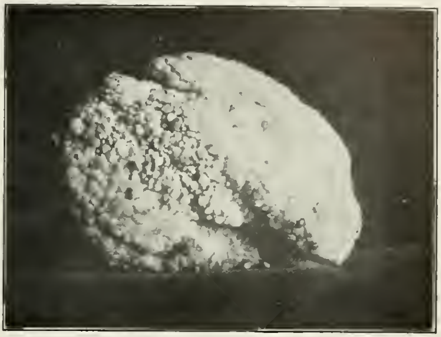

Fig. 217.—Lymphangioma of the Tongue, Removed from a Woman Twenty-two Years of Age. The tumor was first noticed when the patient was four years old. (Original.)

The cause would seem to be, in most cases, insufficient or undeveloped lymphatic vessels, or some obstruction to the circulation of the lymph. The enlargement of the tongue at birth has in some instances been very great; so great, indeed, that death has soon resulted from asphyxia. More commonly, however, nothing is noticed at birth, or only a local affection to which the term "lymphatic nævus" is applied. The tongue may enlarge periodically from recurring attacks of inflammation. Although these attacks seemingly subside, the tongue continues to enlarge at a more or less rapid rate. This gradual extension of the condition led Hutchinson to designate it "infective lymphangioma." Doellinger and Sédillot have each reported a case in which macroglossia developed after division of the frænum, and Girard mentions cases in which it developed after operation on the jaws. It would seem that some micro-organism is an important etiological factor in the recurring inflammation, accompanied as it is by consecutive involvement of more and more of the tongue, and by progressive enlargement of the organ. In Brault's case, pneumococci were found in the cysts. Mikulicz regarded the condition as a hypertrophy and dilatation of lymph-vessels. Virchow noted the similarity between macroglossia and elephantiasis. Butlin attributes the differences found in advanced cases to the changes that take place around these dilated lymphatic spaces. These changes are: (*a*) dilatation and formation of new blood-vessels; (*b*) inflammatory changes, with formation of fibrous tissue; (*c*) new growth of lymphangiomatous tissue. When the enlargement is moderate, or limited to one-half or one-quarter of the tongue, the organ can be retained in the mouth, and it causes but little inconvenience. It is then soft and pliable, although often fissured, and speech and swallowing are little impaired. When it becomes larger and projects from the mouth (prolapse of the tongue), and cannot any longer be retained within the line of the teeth, the distress may be considerable. There is then constant dribbling of saliva; distinct articulation is difficult; and in extreme cases the food cannot be masticated, and must be pushed over the tongue with the finger before it can be swallowed. The surface of the tongue becomes dry and cracked, and ulcers are likely to form. Owing to its increased size, the organ is more than usually exposed to injury, particularly by the teeth; and the injuries thus caused are prone to form ulcers and to bleed. (Fig. 218.) The organ is painful and tender. When the prolapse of the tongue occurs early in life, before the jaws are completely ossified, the pressure produces such a change in the angle of the jaw that when the molars meet together the incisors remain widely separated. The lower incisors become more or less horizontal. (Fig. 219.) Congenital macroglossia has been accompanied by congenital hygroma of the neck. (Winiwarter.) The condition is usually one of slow development. If not interfered with, the hypertrophy may ultimately involve the entire tongue. It is sometimes associated with macrocheilia. The nature of lymphangiomatous macroglossia is revealed by the presence of numerous small

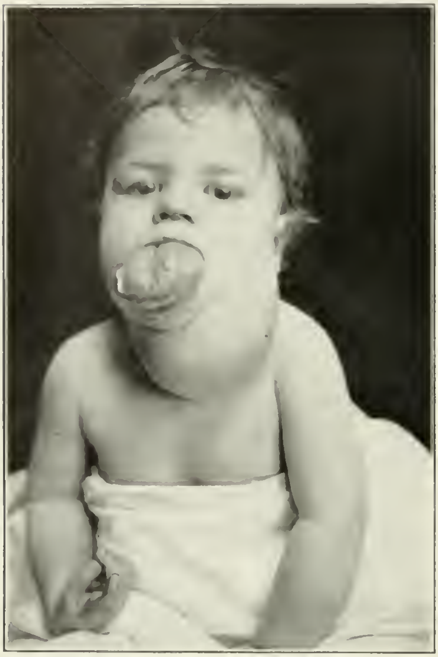

FIG. 218.—Macroglossia Associated with Hygroma. (Original.)

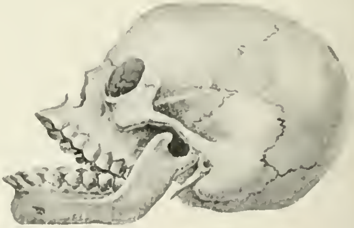

FIG. 219.—Jaws Deformed by Macroglossia; von Siebold's Case. (From Butlin's "Diseases of the Tongue.")

cysts, which can be seen with the naked eye or with the aid of a hand magnifying-glass.

TREATMENT.—Superficial areas of hypertrophy of very limited extent may be destroyed with the thermo-cautery under local or general anæsthesia. This method of treatment should be reserved, however, for very small patches. In all other cases, excision is much to be preferred. A wedge-shaped piece that shall include all of the affected area should be removed, and the incision should extend on all sides into healthy tissue. If any portion of the diseased tissue is left, it will certainly become inflamed from time to time, the inflammation retarding or preventing healing, and the disease again becoming progressive. After the wedge-shaped piece has been removed, the edges of the wound should be brought together. In this way hemorrhage can generally be controlled. The sutures should be of an unabsorbable material. Silver wire forms an excellent suture, and the ends can be bent and placed in such position as shall cause least annoyance and irritation. For this reason silver is preferable to silkworm gut. If it be found necessary to remove the greater part of the tongue, it may be well to tie the lingual arteries (Figs. 220 and 221) as a preliminary measure. Ligature of the linguals has been suggested as a means of a cure. It is doubtful, though, whether this operation has ever been successful in curing a true lymphangiomatous macroglossia.

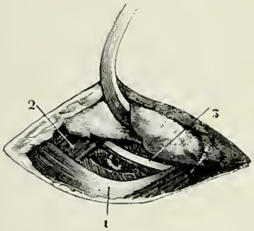

FIG. 220.

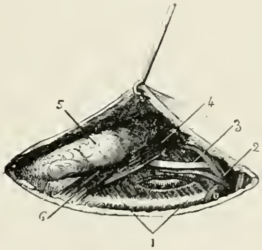

FIG. 221.

FIG. 220.—Ligature of the Lingual Artery (Left Side) in the Little Triangle, above the Tendon of the Digastric Muscle. (After Farabeuf.) Everything that might obstruct the view has been carefully dissected away and the submaxillary gland has been lifted up out of the field of operation. 1, Tendon of the digastric muscle still adherent to the hyoid bone; 2, mylohyoid muscle; 3, hypoglossal nerve. In the triangle the hyoglossus muscle has been incised, and through the opening the lingual artery may be seen.

FIG. 221.—Ligature of the Lingual Artery (Left Side) above the Greater Cornu of the Hyoid Bone. (After Farabeuf.) The field of operation having been cleared by a careful dissection, the following parts may be distinguished: 1, Greater cornu of the hyoid bone; 2, venous trunk made up of the thyroid, lingual, and facial veins; 3, hypoglossal nerve; 4, posterior belly of the digastric muscle; 5, submaxillary gland; 6, point of insertion of the stylohyoid muscle. The buttonhole-like opening in the keratoglossus portion of the hyoglossus muscle permits a view of the lingual artery.

In infants the operation of excision of the tongue is attended by danger, both on account of the anæsthetic and also because of the loss of blood, which is considerable. If the infant cannot nurse, it may be fed with a spoon. If, however, the difficulty in feeding is too great, and if there are recurring attacks of dyspnœa, operation may offer the best chance of life. If possible, it should be postponed until the child is somewhat older—say, from the third to the sixth year. If the operation is done before the tenth year no deformity of the jaw is likely to remain permanently.

Muscular or Simple Macroglossia.—Simple macroglossia, due merely to hypertrophy and hyperplasia of the muscular fibres of the tongue, has been observed, and in some cases in association with the lymphangiomatous form. It may involve the whole or only a part of the tongue. It has been thought to be of nervous origin. It sometimes occurs in *crétins.* (Children with a tongue which is too large for the mouth are generally defective mentally.) Unilateral muscular hypertrophy of the tongue has been associated with a general hypertrophy of the same side of the body. The condition is painless and not subject to recurring inflammation.

TREATMENT.—Active treatment is called for only when the size of the tongue seriously interferes with the taking of food and with the breathing. The difficulty in breathing may cause the sleep to be disturbed, and in this manner retard the growth of the child. The condition is best relieved by the excision of a wedge-shaped piece. Many of these children are short-lived, and only in extreme cases is operation generally considered advisable.

There are other enlargements of the tongue, generally local and of limited extent, that occur for the most part as sequelæ of injuries, of abscess, or of the employment of certain drugs. Their nature is made clear by their histories.

Hæmangioma; Telangiectasis; Vascular Tumors.—The different varieties of dilatation of the arteries, capillaries, and veins observed on the skin are found on the tongue, lips, and inside of the cheeks. They are sometimes congenital, and sometimes acquired. They are sometimes associated with lymphangioma; and when this is the case the latter should be regarded as the more important lesion. They present a great variety of colors, shapes, and sizes. They may remain stationary, recede, or increase in size and extend. The tendency to enlarge and invade neighboring tissues is not as great as in lymphangioma. In children the vessels are more conspicuous during the acts of crying, coughing, or straining. They are sometimes continuous with a similar condition of the skin of the cheek. They are soft, may be emptied by pressure, and refill when the pressure is removed.

An arterio-venous pulsating aneurysm may form in the floor of the mouth as the result of injury. Cirsoid aneurysm or aneurysm by anastomosis has been observed in different parts of the organ by different observers: occupying the tip and right anterior half of the tongue (by Bryant), the left half (by Mott), and the position of ranula (by Fayrer).

CONGENITAL CAPILLARY NÆVI.—Nævi on the outside of the cheeks and lips are sometimes continuous with a like condition of the mucous membrane of the corresponding part of the mouth. Small capillary nævi, similar to those seen on the face, may appear on the mucous membrane of the cheeks, lips, and tongue. They may be on the face and in the mouth of the same patient. In the mouth they are frequently multiple, and on the tongue are sometimes present in pairs. They bear no constant relation to the embryonal fissures.

ACQUIRED CAPILLARY NÆVI.—Acquired capillary nævi on the tongue, in adults, have been reported by Treves and Butlin. Three of the patients were women, and one of Treves's cases was a man. In two cases the nævi appeared in women during pregnancy. The man was fifty-seven years of age, plethoric, and had suffered from epistaxis since boyhood. His grandfather, his father, two uncles, two brothers, one son, and two daughters had suffered from recurring attacks of hæmoptysis. Nine bright-red tumors, that varied in size from a pin's head to a split pea, were present on the otherwise normal-looking tongue. It appeared that, after the bleeding from the tongue had made its appearance, the epistaxis ceased. The blood lost was a bright red, and the bleeding generally occurred during or after eating. The loss of blood had been sufficient to render the man anæmic. The bleeding was arrested by painting the part with a ten-per-cent solution of chromic acid, but the arrest of the bleeding at this point was followed by a recurrence of the epistaxis. In one of the women the bleeding came from a non-pulsating tumor that resembled a raspberry and proved to be a pure arterial angioma. In another woman there were several tiny nævi, precisely like those seen on the septum nasi; and one of larger size, that did not stand out from its base in the form of an ordinary tumor, but represented rather a depression or excavation.

CAVERNOUS TUMORS.—Cavernous tumors and venous angiomata are probably the most frequent of all forms. They occur beneath the mucous membrane of the lips, cheeks, and tongue; are generally of a bluish color; may or may not be emptied by pressure; are painless, and cause inconvenience only by their size. As a rule, they are congenital; but probably they are sometimes acquired. In many cases they show but little or no tendency to enlarge, but in other cases they increase gradually until a large part of the tongue is converted into cavernous tissue.

In all the different forms of hæmangioma there would seem to be a tendency to approach the surface by causing pressure-absorption of the overlying areolar tissues and mucous membrane. When the latter is sufficiently thinned, recurring hemorrhages are likely to occur under slight provocation, such as trivial, often unavoidable traumatism during eating or at other times. On the other hand, they sometimes lessen in size as the result of fatty degeneration.

Nævi are generally easily recognized. Their occasional association with lymphangioma should be remembered.

Treatment.—Nævi involving the mucous membrane of the lips and cheeks call for active treatment when associated with lymphangioma; when steadily increasing in size and extent; and when causing offence by their conspicuousness. When situated on the tongue, they may interfere with speech or mastication, or from their size they may cause difficulty in swallowing. In extreme cases, the nævoid tongue may, by virtue of its size, project from the oral cavity.

Small nævi are effectually and easily destroyed by the point of a thermocautery at a dull-red heat. When the tumor is larger, the fine platinum point (at a dull-red heat) may be pushed into the mass and moved about until the vascular tissue is destroyed. Very satisfactory results are obtained by electrolysis. A pair of fine platinum needles, placed parallel with each other and fixed in a convenient handle, is a ready and convenient form of instrument. The needles should be attached to a battery, and the number of cells used should be simply sufficient to decompose water when the needles are held in a glass containing it. Such decomposition is indicated by the fact that bubbles collect about the needles. When this fact has been determined the needles are inserted into healthy tissue at the margin of the nævus, and passed on into the substance of the tumor. They should be made to penetrate in different directions until the whole mass has been acted upon. There is little or no hemorrhage. Some surgeons prefer to use one needle attached to the positive pole, while the negative pole is attached to a large electrode, moistened and placed on some other part of the body. If the positive pole alone is used, it is necessary to employ a current of from two to four milliampères, as measured by a galvanometer, and to allow its influence to be exerted for ten or fifteen minutes. If both needles are employed, a current of half this strength is sufficient. The negative pole, if the current is strong, may cause sloughing of the tissue and subsequent scarring, by producing a compound of caustic sodium. The writer has used both methods with success and satisfaction. The electricity produces physical and chemical changes in the blood. An anæsthetic is required, and the operation may need to be repeated once or twice. The scar left is slight and inconspicuous. In suitable cases electrolysis is the preferable method.

Large, extensive, and prominent nævi of the tongue are often best treated by excision. An ovoid or V-shaped incision is made, and the edges of the wound are brought together by sutures. The result is satisfactory; a linear cicatrix remains. The old method of strangulation by deeply placed ligatures causes sloughing of the mass and often of the adjacent healthy tissues. Sepsis and septic pneumonia may develop, and the scar which results is depressed, large, and conspicuous.

Another method which should be regarded as obsolete is that by injection of coagulating or irritating fluids. Perchloride of iron, carbolic acid, absolute alcohol, and other fluids have been injected. They are uncertain in their action, and not without danger. Ligature of one or both lingual arteries has been employed as a curative measure. The benefit has generally been found to be temporary, because of the very free anastomoses. Ligature of the lingual arteries may be advisable in cases of very large lingual nævi, as a preliminary measure before excision is undertaken. (Figs. 220 and 221.)

Recently, liquid air has been applied to superficial nævi by means of a stick, around one end of which absorbent cotton is wound. A cold equal to 320° F. below zero is obtained. A crust forms, which subsequently drops off, leaving a smooth soft surface. This method is highly recommended by those who have used it.

Simple, Benign, Solid Tumors.—There are a number of innocent solid tumors that are occasionally observed on the tongue. Such, for example, are lipoma, papilloma, fibroma, and fibromyoma. They are sometimes congenital, but more frequently they are acquired.

LIPOMA.—Fatty tumors have been observed on the tongue, floor of the mouth, lips, gums, and soft palate. When situated in the walls of the mouth, they are always submucous. On the tongue they may lie just beneath the mucous membrane, or be deeply placed between the muscles. When congenital, they are often mixed tumors. More frequently they occur in elderly people, or at least in people past middle life. They are sometimes multiple—five, six, or even a larger number being present. Occasionally they are diffuse. When they are situated beneath the mucous membrane, their character can generally be determined without much difficulty. The mucous membrane covering them is smooth and velvety, owing to the absence of the papillæ, and it can be pinched up. The tumors are sometimes lobulated, soft, and pseudo-fluctuating and movable, and, owing to the thinness of the overlying mucous membrane, the yellow color of the fat can often be seen. Common sites on the tongue are the border near the tip and the dorsum. When these tumors are deeply situated between the muscles of the tongue, their true nature may be discovered only after an incision has been made. Their growth is exceedingly slow. Ten or fifteen years may elapse before they attain the size of a plum.

Treatment.—These lipomata are painless, innocent in character, and, as in other situations, simply cause inconvenience by their size. If the growth is large, and if it interferes with speech and mastication, it may be removed with safety. If pedunculated, it may be removed by tying the pedicle and the contained vessels, and snipping off the tumor; and if the growth is sessile, the overlying mucous membrane may be divided, and the tumor shelled out. When it is deeply seated between the muscles of the tongue, it is often better to make an incision beneath the chin and remove the mass in this manner than to establish an opening in the mouth; the danger of infection and of an unduly prolonged convalescence will thus be avoided.

FIBROMA AND FIBROMYOMA.—Fibromata are found on the surface of the tongue, and occasionally on the uvula and palatal arches. They are composed of connective tissue for the most part, but vary much in their density;

the cellular elements often predominating. They are sometimes so soft as to convey a sensation of pseudo-fluctuation that is exceedingly deceptive. In other cases they are very hard. The structure has, in one instance at least, been that of a fibromyoma. Pendle reported a tumor, the size of a pigeon's egg, in the left half of the tongue. This tumor was composed of striped muscle fibres (rhabdomyoma). Not infrequently these tumors are multiple. While generally observed in adults, they occur also in children, and may be congenital. They are, at first at least, situated in the body of the tongue, but may come to the surface and become pedunculated. Their surface is sometimes nodular. The mucous membrane covering them may be thin, but is not adherent. They are of exceedingly slow growth, quite innocent, and painless. They are often discovered by accident, and cause mechanical inconvenience, according to their size and situation.

Diagnosis.—The diagnosis in many cases is easy, but sometimes it may be a matter of great difficulty. When the tumor is soft, it may resemble a lipoma, an angioma, or a cyst; when hard and nodular, it may resemble a tuberculous mass, a sarcoma, a gumma, an endothelioma, or a nodule of actinomycosis. The difficulty is still great when, from pressure or other cause, an area of ulceration has developed. Error may in general be avoided by a careful search for the usual accompaniments of the above conditions, and by a close consideration of the clinical history. As before mentioned, connective-tissue tumors increase very slowly. The increase in size during a period of years may be scarcely appreciable. In cases of difficulty the use of an exploring needle or the removal of a small piece for microscopic examination may be required to clear up the diagnosis.

Treatment.—The treatment is removal by enucleation or by division of the pedicle, when the tumor causes inconvenience.

PAPILLOMA.—Papillomata or the so-called warty growths occur for the most part on the upper surface of the tongue, but are also seen underneath in the neighborhood of the frænum. When they occur on each side of the frænum in children, as a result of irritation by the lower incisors (as is sometimes observed in whooping cough, etc.), they constitute what is known as Riga's disease. Papillomata are often multiple. In some instances all the papillæ on the dorsum of the tongue may be enlarged and appear as so many warts.

Patients sometimes complain of pain in the foliate papilla which is situated just at the junction of the border of the tongue and the anterior pillar of the fauces. It can be brought into view by pulling the tongue forward and to one side. It is often red, and may have a depression in the centre. The patients are generally nervous and apprehensive, and often consult their physician in great alarm, fearing the beginning of cancer. The writer has had great difficulty in quieting the fears of these people, and at times the fears also of their family physician. In fact, one or more consultations with specialists are sometimes necessary to allay their alarm.

The condition is one which I have always thought to be due to some kind of indigestion, and I have generally succeeded in relieving it by dietetic treatment. If, on careful examination, no induration can be felt, a positive statement can be made that there is no malignancy present. The two sides are generally quite alike. It has been suggested that the pain and swelling may be an evidence of a gouty or rheumatic diathesis.

Thickening and warty outgrowths on areas of leucoplakia are most suggestive of commencing malignancy, and demand prompt attention.

Diagnosis.—It is not always by any means easy to make a diagnosis. In children and young persons papillomata may resemble condylomata. A careful inquiry should be made for signs or a history of syphilis. In doubtful cases their nature may sometimes be determined by the therapeutic test.

In adults warty growths may easily be mistaken for epithelioma, and the differentiation will have to be based upon the presence or absence of induration, ulceration, and fixity. Bull has noticed that a coincidence seems to exist between papillomata on the posterior section of the tongue and similar multiple growths in the larynx.

Treatment.—Papillomata tend to persist, slowly to enlarge, and to assume the characteristics of a malignant growth. Even in children, it is well to remove them. This should be done so thoroughly that the whole growth is destroyed. When there are multiple papillomata, excision of each one may be out of the question. In such cases the use of the galvano-cautery or the application of liquid air will be found efficient. Ordinary caustics rather stimulate to more rapid growth, and should never be used. If there is only one growth, and if the patient is over thirty years of age, and also in all cases where there is induration or where the growth appears on a leucomatous area, excision by means of an elliptical incision that includes the base and a little margin around, should be practised, the edges of the wound being brought together by sutures.

Endothelioma.—A number of endothelial tumors have been reported since their clinical and microscopical characteristics were pointed out by Nasse and Rudolph Volkmann. They are benign, mixed tumors, thought to commence by proliferation of endothelium in a lymph space or in the blood capillaries. They are recognized microscopically by the plexiform disposition of the rows of cells and by the presence of a certain amount of hyaline degeneration. These tumors are of slow growth, which may extend over three or four years; they are soft and often lobulated; the mucous membrane is movable over them; and they are encapsulated. In the oral cavity, their most common site is at the junction of the soft palate and the arcus palato-glossus. They also occur in the submaxillary glands, particularly the left. They have been observed at all ages and in both sexes. They sometimes undergo cystic degeneration. In other instances they are reported to have burst through their capsule, and then to have assumed the characteristics of a malignant growth. Tumors containing bone and cartilage have been found at the base of the tongue. When endotheliomata are located deep in the substance of the tongue, it is probable that they are of congenital origin, having sprung from the fœtal structures from which is developed the septum. Those found on the surface of the tongue are thought to take origin in the mucous glands situated in front of the pillars of the fauces, and to be endothelial in origin. So long as they are surrounded by a capsule they may be enucleated without difficulty, and then do not tend to recur; but if they are not removed until after they have extended beyond the limits of the capsule, they should be regarded as malignant and dealt with as such. Hard tumors containing bone and cartilage may be removed under cocaine. The hemorrhage is usually trifling.

AMYLOID TUMORS OF THE TONGUE.—Amyloid tumors occur in the tongue as well as in the conjunctiva, larynx, trachea, and lymph nodes. They may occur without any definite relationship to inflammatory processes, and in situations where but little normal fibrous tissue is present.

Barow, Manasse, von Schroetter, and others say that they develop from connective-tissue tumors, infiltration occurring in granulations, in chronic inflammatory tissue, and sometimes in scars. Ziegler reported a case in 1875. Since then several have been reported, including one by Gross[23] in a recent issue of the *Deut. Zeit. f. Chirurgie.* In this case the patient was a male, aged fifty-seven, who during the previous five weeks had found difficulty in swallowing. The tumor was hard and globular, about the size of a hazelnut, and extended back to near the epiglottis. The mucous membrane was intact. There was a slight gingivitis, an increased quantity of saliva was secreted, the epiglottis and larynx were reddened, and the lymph nodes in the submaxillary region were enlarged and tender. The small piece removed with the scissors for microscopical examination showed the growth to be of an amyloid character. The tumor was removed by an incision made beneath the chin. The patient made a good recovery. The enlarged lymph nodes gradually decreased in size. The following pathological report is by Professor Borst of Goettingen:—

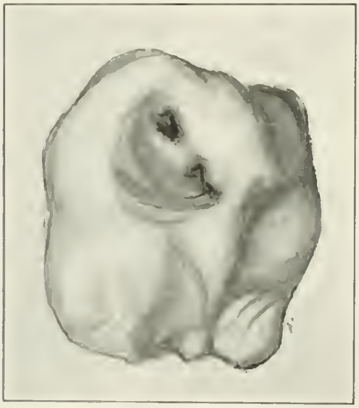

FIG. 222. Bony Tumor Removed from the Tongue by Operation. One-half larger than natural. (Case of Dr. Mackenzie.) The weight of the tumor was 20 grams. It measured 3.7 cm. × 3.7 cm. × 2.6 cm.

Salivary-gland tissue is intermingled with thick bands of connective tissue and a few bands of muscle. At one point the tissues are separated by an infiltration of small cells, while the neighboring gland cells are atrophied. The mucosa of that part of the tongue which overlies the tumor is thinned, the submucosa being infiltrated with inflammatory cells. In another part of the tumor there are homogeneous, gelatinous-like masses between which are connective-tissue septa, muscle fibres, and the remains of fat tissue. These masses are of various shapes, and some of them are calcified. The amyloid transformation may be seen in the walls of the blood-vessels and in the membrana propria of some of the gland ducts. These masses give a positive amyloid reaction.

At first, the tumor was thought to be a carcinoma.

As not unimportant diagnostic points in a glossal amyloid tumor may be mentioned: the absence of any tendency to break down and to ulcerate; the flat elevation of the tumor; and, most important of all, the situation—always in the same place at the very back of the tongue. In Ziegler's case there were three nodes on both sides of the middle line; in other cases there have been only two nodes.

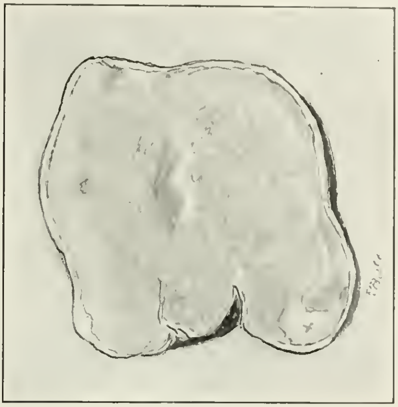

Fig. 223.—Surface of Section of the Tumor Shown in Fig. 222. (Original.) The only portion that is cartilaginous is at the point marked by x. The rest is pure bone, as may be seen in the microphotographs (Figs. 224 and 225).

Osteoma of the Tongue.—Dr. Ridley Mackenzie presented a unique specimen of osteoma of the tongue before the Montreal Medico-Chirurgical Society. The tumor weighed 20 grams, and measured 3.7 cm. × 3.7 cm. × 2.6 cm. On its lower end were a few patches of cartilage, but everywhere else throughout the tumor there was true bone, and not a mere calcification. It was covered by mucous membrane. On one side there was an ulcerated area.

Only those micro-organisms which habitually frequent the mouth were found. The woman applied to Dr. Mackenzie to have an anæsthetic administered, in order that her few remaining teeth might be removed. An examination of the mouth then revealed the presence of a pedunculated tumor that sprang from the dorsum of the tongue, just to the left of the median raphe, midway between the tip and the base. Its short pedicle allowed it to fall backward. It did not interfere much with deglutition or speech, and caused no inconvenience during the giving of the anæsthetic. The woman stated that she had had the tumor all her life, and that at four years of age an unsuccessful attempt had been made to remove it. Mackenzie ligatured the pedicle and snipped it off. I know of no record of a similar case. The most likely theory of its origin would seem to be that it is an inclusion tumor. (See Figs. 222–225.)

CHONDROMA.—Camus and Ertzbischoff report the removal of a chondroma from the tip of the tongue of a young woman twenty-one years of age. It was noticed four years before, and had increased in size steadily.

ADENOMA; SUPERNUMERARY THYROIDS.—A number of cases of so-called glandular tumors of the tongue have been reported by different observers. They have all or nearly all been in women. They have been described as developing from remnants of the embryonic middle lobe of the thyroid gland. They have usually been found at the base of the tongue, near the epiglottis and the foramen caecum, and occasionally deep down near the hyoid bone—the so-called accessory thyroids. They may be smooth or notched. They are vascular, soft, and elastic, and may interfere with swallowing. Seldowitsch reports a case in which myxœdema developed after the removal of an accessory thyroid tumor at the base of the tongue. That they are really adenomata has been questioned. Butlin says that "the insufficiency of the histological description prevents one from identifying them." Allen[7] reports the removal of a supernumerary thyroid from the base of the tongue of a young woman, eighteen years of age. It was egg-shaped, and 4 cm. in its greatest diameter. It seemed to be distinctly encapsulated, and divided into three very distinct lobes by trabeculæ of connective tissue. In each lobe was a small cavity. In 1902 Winslow collected the records of thirty cases, and he reported one of his own.

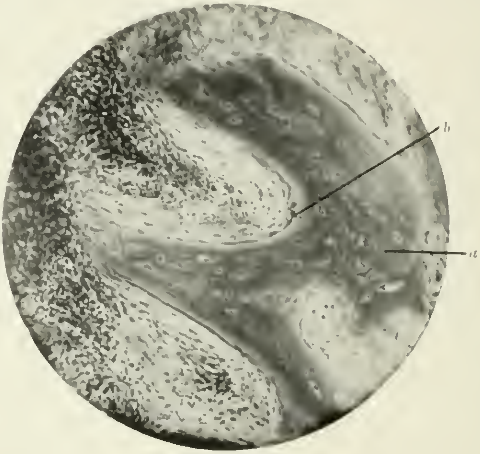

FIG. 224.—Microphotograph of a Pedunculated Osteoma of the Tongue. × 600 diameters. (See Fig. 222.) *a*, Hyaline cartilage with irregular cartilage cells; *b*, marrow cells.

Riethus[8] reports a case of struma lingualis occurring in a young woman seventeen years of age. Troublesome symptoms had been present for four or five months. The tumor was of the size and shape of a walnut, and one section presented a typical colloid strumous structure. Microscopically, the picture was that of an ordinary colloid struma. On the periphery were found isolated acini, the lumina of which were not yet filled with the colloid mass. Riethus has collected reports of seventeen other cases. Tracheotomy, with tamponing of the trachea, should always be performed in those cases in which the pharynx must be opened during the removal of the growth. The total number of cases so far reported is about thirty-two. The cause must be referred to a malformation or inclusion of a part of the normal thyroid in the first week of fœtal life.

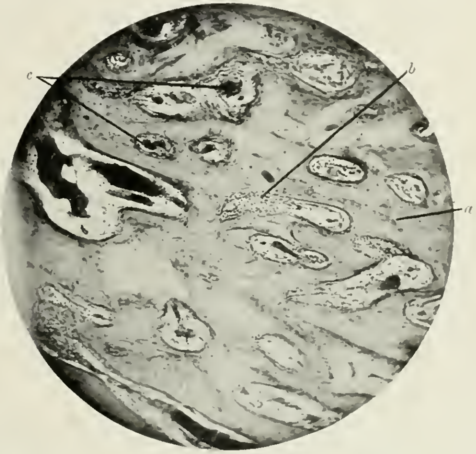

FIG. 225.—Microphotograph of a Pedunculated Osteoma of the Tongue. × 300 diameters. (See Fig. 222.) *a*, Bone trabeculæ with bone cells; *b*, marrow cells; *c*, blood-vessels.

These tumors have generally been removed through the mouth. Hemorrhage may be profuse; so much so, indeed, that it is advisable to do a preliminary tracheotomy in order that the pharynx may be plugged and blood prevented from entering the larynx.

KELOID.—Sedgwick reports the presence of a patch of keloid on the right side of the tongue in a little girl between four and five years of age. There were patches, regarded by Sedgwick as Addison's keloid, on several parts of the body. Mr. Morrant Baker reported an instance of the development of Alibert's keloid, following a bite on the left border of the tongue, in a young man aged twenty-three. In the case of the little girl, the patch spread along the border of the tongue toward the tip, and gave the appearance, when the tongue was protruded, of having developed in scar tissue.

RANULA.—Ranula, a term of doubtful origin and meaning, is in common use to indicate a translucent cystic swelling in the floor of the mouth, underneath the mucous membrane, between the tongue and the incisor teeth. In most cases it is a retention cyst, located in one of the sublingual glands, the duct of Rivinus, or one of the ducts of Walther. It may be of congenital origin, due to malformation of the ducts; but generally it is acquired. The obstruction may be due to inflammatory conditions, to subsequent narrowing produced by fibrous tissue, or to the presence of calculi or a tumor. Ranula does not seem to follow the inflammation arising from carious teeth, etc. As a rule, to which there are very few exceptions, ranula is unilocular, and the contents are ropy, viscid, and clear. The tumor is generally located on one side, at first at least; and if it extends across the median line, it may be grooved by the frenum. A baby seven weeks old was recently treated in the outdoor department of the Montreal General Hospital for a bilateral double ranula, Wharton's duct being the seat of disease on each side. That Wharton's duct is free may be proved by passing a fine silver-wire probe along its course. The mucous membrane is movable over the swelling, and the vessels are often conspicuous.

Ranulæ are sometimes quite large and prominent, and may interfere with speech and respiration. In rare instances, the tumor projects beneath the chin. Traumatism and secondary infection may lead to sloughing of the floor of the mouth. When a ranula occurs in a child it may, if allowed to remain, push forward and alter the shape of the lower jaw and teeth, and cause them to become everted. Atrophy of the gland occurs in the chronic form of the disease.

Three different forms of ranula may be observed: the acute, the intermittent, and the chronic. In the acute form the tumor may develop very quickly from sudden obstruction of the duct. Du Cane reports the case of a man in whom bilateral ranula developed suddenly while he was eating. The swelling increased until only the under surface of the tip of the tongue could be seen. He had difficulty in breathing. After the swelling had been incised saliva flowed freely. There was no recurrence.

In minor degrees of the condition the cause may prove to be a plugging of the orifice of the duct by a small calculus or by a plug of mucus.

Pain is sometimes an accompaniment of the disease, and may be severe.

In the intermittent form of ranula the tumor disappears spontaneously or under the pressure of the finger, and then shortly afterward returns. This form is most easily explained by assuming that a small calculus blocks the opening of the duct temporarily, and then drops back, allowing the saliva to escape.

In the chronic form the swelling may gradually increase or it may remain materially unchanged. The latter behavior may be explained in two ways: in some cases there is probably an escape of saliva at intervals, while in others the salivary gland undergoes such a degree of atrophy that there is but little secretion.

Although ranula is more commonly associated with the sublingual, a similar condition may obtain in connection with other glands. If Wharton's duct be obstructed, the swelling may occur in the submaxillary region. Then, again, the Blandin-Nuhn glands underneath the tip of the tongue may be involved, in which case the ranula would be projected with the tongue. Neumann thinks that a cyst may develop from the tubule of one of Bochdalek's glands, which are connected with the lingual duct—a branch of the upper part of the thyro-glossal duct. The incisive glands, which lie on the periosteum immediately beneath the central incisor teeth, may be involved. Morestin has demonstrated that prolongations of the sublingual glands may be found between the fibres of the mylohyoid muscle. This fact would explain the occasional appearance of swelling in the submental region after the ranula proper had been removed.

Diagnosis.—Ranula is the most common cystic formation that is found limited to the region of the frænum. Dermoid cysts have thicker walls, pit on pressure, and are not translucent. The chief distinguishing feature of a dermoid cyst, however, is said to be adhesion to the jaw or the hyoid bone. A lipoma is different in color. Lymphangiomata and vascular tumors are seldom limited to this region. Cystic hygroma of the neck may resemble chronic ranula or a dermoid cyst. The diagnosis, although generally apparent from the situation of the tumor and its translucency, may, in obscure cases, be made certain only by an incision.

Treatment.—Two methods of treatment are to be commended:—The anterior portion of the sac wall may be excised, and the remainder first painted with pure carbolic acid, and then with alcohol or a solution of chloride of zinc or nitrate of silver. This method is seldom, if ever, followed by recurrence. A more ideal method is to incise the mucous membrane overlying the tumor, and then, by blunt dissection, to remove the cyst entirely. Koenig and others have advised that the sublingual gland be also removed. They claim that, unless this is done, a bit of cyst wall is likely to remain, and thus to give rise to the formation of a fistulous track. This operation is done through the mouth under cocaine anæsthesia. If the cysts are submental and connected with the lingual portion of the thyro-glossal duct, incision beneath the jaw is required, and a most careful dissection of all the visible cyst spaces will have to be made. Even then recurrence is frequent, and repeated operations are often necessary before a permanent cure can be effected. Recurrence in these cases is sometimes deferred for months or even for a year or two. Both the patient and the operator may become discouraged, but persistence is always followed in the end by a permanent cure. The employment of setons, of injections with iodine, etc., is unsatisfactory and uncertain, and is not to be recommended.

Sialolithiasis—Salivary Calculi.—Salivary calculi are composed of phosphate of lime, with some carbonate of lime and organic matter. Klebs and Galippe have shown that they are due to bacterial invasion of the duct in which they are found. Masses of bacteria are often found in the interior of these calculi. Invariably an increase in the degree of alkalinity and a diminution of the acidity of the secretion have preceded the formation of such stones. It is now believed that inflammation of the duct-lining occurs as the result of the entrance of bacteria, and that swelling of the mucous membrane, stasis of the outflow of saliva, roughening of the wall of the duct, and finally stone formation ensue. Foreign bodies, as nuclei, are not common, although hair and particles of grass have been found. In Alexander's case of calculus in the submaxillary gland, with a history extending over a period of thirteen or fourteen years, the calculus gave a pure culture of leptothrix, an organism always found in the mouth. The pathogenesis of salivary calculi would then appear to bear a striking resemblance to that of cholelithiasis. The resemblance again appears in the particular locality affected. The salivary calculi, in the great majority of instances, are found in the main duct of the gland—Wharton's or Steno's,—but also occasionally in the fine radicles of these ducts in the gland tissue.

Over 60 per cent of all salivary calculi, according to Czygan, Buchwald, and Wienzel, develop in Wharton's duct, 20 per cent in Steno's duct, and 18 per cent in the duct of Rivinus. They have also been met with in the ducts of the Blandin-Nuhn glands. They vary greatly in size. In Wharton's duct they may be as small as millet seeds, or they may measure an inch or an inch and a half in length; and they have been reported as weighing as much as 20 gm. When occurring in the gland substance they are usually quite small, and may escape through the duct from time to time. The larger ones are usually long and tapering at each end. The surface is usually rough. The consistency is also variable; sometimes they are very dense and hard. In color they are a grayish or yellowish-white. Although Burdel has reported a case in which a salivary calculus was observed in a child aged three weeks, the disease is essentially one of middle life, and more common in men than in women. They often develop painlessly, the saliva escaping around the calculus or along a groove on its surface. If secondary infection occurs, with swelling of the mucous membrane of the duct, a ranula may form. In other cases the duct ulcerates, and perforation may be followed by a fistulous opening through which offensive purulent discharges enter the mouth. Perforation sometimes occurs in the submaxillary region beneath the jaw. The inflammation around the duct may spread along the floor of the mouth, and abscesses may form.

Diagnosis.—As a rule, the diagnosis is easily made. The patient complains of a hard lump under the tongue or of pain and the frequent escape of a few drops of pus—pyorrhœa salivalis. The finger introduced into the mouth feels the stone. More rarely, the patient gives a history of what the French term "colique salivaire," by which is meant the sudden onset of pain and swelling due to the increased secretion of saliva when taking food. The sight or smell of food may induce an attack. The pain is not relieved until the pressure behind the stone is removed by the escape of the saliva. These attacks sometimes recur with almost every meal. A much more serious difficulty in diagnosis obtains in certain cases where the stone has excited a more chronic form of inflammation, with chronic thickening and infiltration of the adjacent tissues. Under these circumstances it may be impossible to distinguish a stone with the finger. Its presence, however, may be detected by the aid of an exploring needle. In one case of which I have knowledge it was detected by the use of the Roentgen-ray. In another case a chronic inflammatory mass such as I have just described was mistaken for a malignant growth, and a portion of the tongue was sacrificed before the error was discovered. The use of the exploring needle and a resort to a microscopical examination should prevent a serious error.

Treatment.—If the stone is distinctly felt in the duct, it may easily be removed under local anæsthesia, through an incision made directly over it. Small stones may sometimes be dislodged by pressure. In both cases a mild antiseptic mouth wash should be used for a few days afterward. Recurrence is uncommon. If the stone is felt through an external fistulous opening, it should be removed through an external incision. (See also p. 442 of Vol. V.) Stones situated in the substance of the submaxillary gland are often best treated by extirpation of the gland. A stone in the parotid must be removed by an appropriately placed external incision, care being taken to avoid the facial nerve. When possible, however, it should be removed by way of the mouth. Stones have been successfully removed from Steno's duct from the outside, with suture of the duct immediately after the removal. Abscesses should be opened and drained.

Dermoids.—Dermoid cysts under the tongue and lower jaw, as elsewhere, are distinguished by their lining membrane, which is composed of stratified epithelium, and by a capsule of fibrous tissue, inflammatory in origin. The contents are sebaceous matter, sebaceous glands, and sometimes hair, generally of a downy character. They may have an odor of fatty acids. These cysts originate early in fœtal life, at the period when the epiderm and endoderm are being separated by the mesoblast. They are thus distinct in origin, as well as in other characteristics, from cysts due to dilatation of the thyro-glossal duct, with which they were at one time confounded. Although not infrequently noticed for the first time in adult life, they are always congenital in origin. Dermoid cysts may remain latent for years. They are sometimes noticed at or soon after birth, the cyst being felt as a small lump or nodule. This form of cyst may have periods of increase followed by years of quiescence.

As a rule, dermoid cysts are situated in the median line, and are attached either to the genial tubercles of the lower jaw or to the hyoid bone by a fibrous band. In other cases there is no such attachment, and they may be placed somewhat laterally. They generally lie between the geniohyoglossi muscles, occasionally extending deeply into the muscles and appearing in the epiglottic region, but more commonly they push up the floor of the mouth and the tip of the tongue, or they grow downward and appear beneath the skin, between the jaw and the hyoid bone. They are then below the mylohoid muscle. When the cyst is large, it may be impossible to determine exactly the point from which it originates.

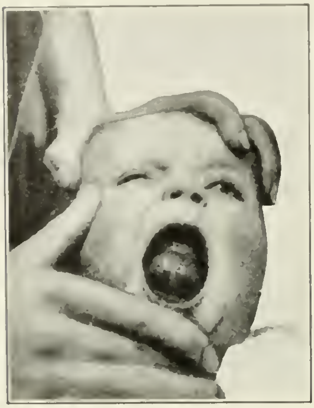

FIG. 226.—Sublingual Dermoid. (De Quervain.)

If not interfered with or injured, dermoid cysts seldom become tender or inflamed. When irritated or punctured, infective inflammation may occur, followed by suppuration and the formation of a fistula.

Diagnosis.—The diagnosis was referred to in speaking of ranula. (Page 259.) Dermoids are easily palpated through the mouth or beneath the jaw. The mucous membrane and integument are normal in appearance, and movable over the cyst. Fluctuation is present, and a characteristic sign which is often present is pitting on pressure. (Fig. 226.) The growth of the cyst is always slow. According to Roland, in 50 cases it was seen 4 times in children under five years, 4 times in those under fifteen, 27 times in individuals between the ages of fifteen and twenty-five, and twice at the age of fifty.

Treatment.—There is only one satisfactory way of treating dermoid cysts, and that is to remove them. This may be done in many cases by approaching the cyst through the mouth. An incision is made through the mucous membrane, and the cyst can then be enucleated by blunt dissection. A band of attachment to the lower jaw may require division. The advantages of this method are that it may often be carried out under local anaesthesia, and that no visible scar remains. Infection of the space is almost certain to follow, and may delay convalescence. Many surgeons prefer to make an incision through the skin, between the lower jaw and the hyoid bone, and then to reach the sac by separating the geniohyoid muscles. A band attaching the cyst to the lower jaw in the neighborhood of the genial tubercles, or one attaching it to the hyoid bone, may require division; otherwise the cyst is removed by blunt dissection. The operation is somewhat facilitated by allowing part of the sac contents to escape. It is more difficult to remove the sac if there has been much inflammatory action around it. The dead space remaining can be obliterated by buried sutures of fine catgut, or a gauze drain may be left in place for forty-eight hours. Dermoid fistulæ require excision.

Teratoid Tumors.—Teratoid tumors, the origin of which is still under discussion, have been observed attached to the vault of the pharynx near the

EXPLANATION OF PLATE XL.*

PATHOLOGICAL CONDITIONS OF THE TONGUE.

A.—Epithelioma of the tip of the tongue, said to be of only two weeks' duration. It occurred in a man thirty-six years of age. As regards the situation and appearance of the lesion it bears a close resemblance to a primary syphilitic lesion. The patient's mother died of carcinoma of the stomach at the age of seventy-five.

B.—Double Ranula of Wharton's duct.

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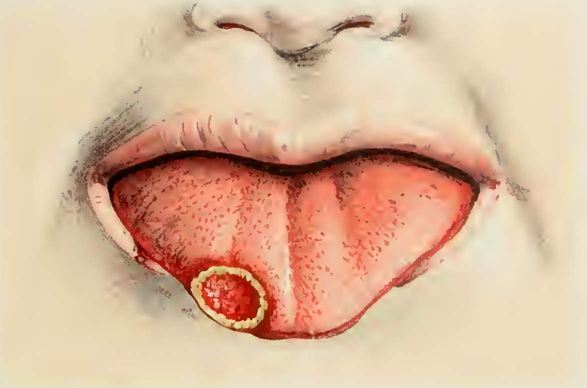
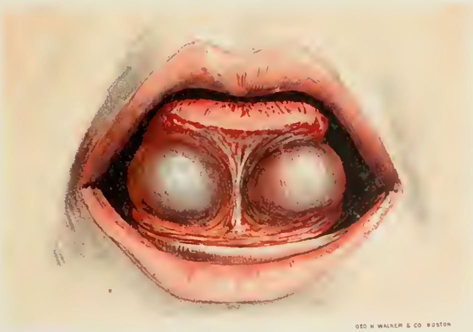
* Plates XXXVII, XXXVIII, and XXXIX, belonging to the article on Diseases of the Jaws, will be found at the end of this volume. This change was found necessary in order to avoid a serious delay in the publication of the volume. These inset plates are printed at a much earlier date than the text which they accompany, and it is therefore impracticable to give them new numbers if afterward it should be decided to change the order of the articles.—The Editors.



A

Epithelioma of the Tip of the Tongue
(Dr. Armstrong)



B

Double Ranula of Wharton's Duct
(Dr. Armstrong)

openings of the Eustachian tubes, to the palatal arches, the tonsils, and the hard palate. Niemczyk has collected reports of twenty cases. The tumors are small and are characterized by their epidermoid covering. While they are composed largely of fat, they may also contain bits of cartilage, bone, and striated muscle fibres. They seldom cause any trouble unless situated near the epiglottis, in which situation they may irritate the posterior pharyngeal wall, inducing a distressing cough or nausea and retching. If the tumor is pedunculated, the pedicle may be tied and the tumor snipped off; if it is sessile and causes inconvenience, it may be enucleated.

Malignant New-Growths.—CARCINOMA.—Cancer of the tongue is a most malignant form of disease. Senn and others would apply the term "epithelioma" to benign cases only; yet, in the words of Orth, "the characteristic and distinguishing feature of cancer cells is that they are none other than epithelial cells. They are epithelial cells, not only in accordance with their structure, with respect to the nature of their protoplasm and nuclei, and as regards their biological activities, but also in accordance with their origin. A connective-tissue cell can never be transformed into an epithelial cell, nor *vice versa*."

Epithelioma of the tongue may be said to be always of the squamous variety, although Steiner has reported one composed of cylindrical cells. (Plate XL, A; Plate XLI.) The influences which change a benign epithelial cell into a cancer cell are not known. That continued irritation and malnutrition are predisposing influences can hardly be doubted. That there is a parasitic cause is not proven. To prove this, one must find a germ which, injected in pure culture into a part, will produce cancer; and such a germ has not yet been discovered. The predisposing influences of continued irritation should be keenly appreciated by the profession and the public. A good dentist can become a public benefactor by removing sharp corners of teeth and by filling up holes in which food may collect and give rise to irritating substances and gases. I feel satisfied that I have seen several cases of lingual cancer that owed their existence, in part at least, to an unhealthy condition of the mouth and teeth.

Another evidence of the fruitful influence of various irritations in the etiology of malignant disease is afforded by the fact that carcinoma is relatively more frequent in men than in women. Kuemmel, who writes on this subject in von Bergmann's "System of Practical Surgery," states that, of 1,000 women affected with cancer there were only 13 in whom the lips, oral cavity, and tongue were the parts involved, while in 243 the mammæ were the seats of the disease. In 8 of these 13 cases the cancer was found on the lips, in 3 on the tongue, and in 2 in other parts of the mouth. Of 1,000 cases of cancer in the male sex, there were 111 in which the oral cavity was involved—77 on the lips, 21 on the tongue, and 13 on other parts of the oral mucosa.

It is not yet conclusively proven that cancer is more common than formerly. "There is nothing in the statistical investigations of the Imperial Cancer Research Fund which points to an actual increase in the death-rate from cancer"; although Barker has published figures that would seem to show that in England, during the years 1872–1881, the number of cases of cancer of the tongue had increased from 26 per 1,000 to 115 per 1,000.

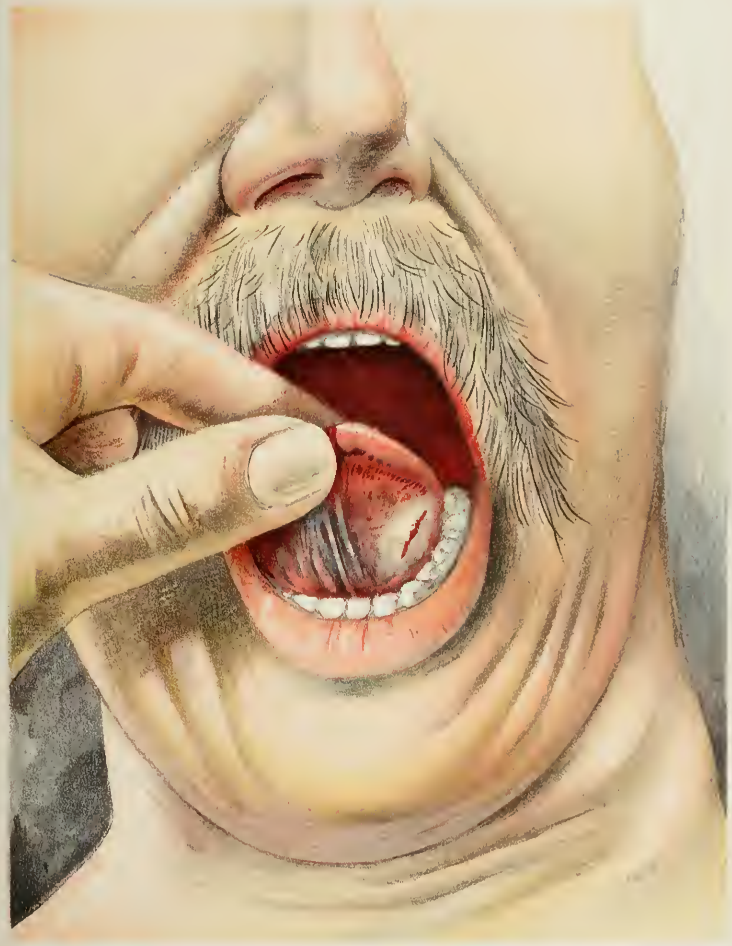
While any part of the tongue may be the seat of cancer, the borders and anterior half are more frequently involved than the dorsum, under surface, or the base behind the V. (Plate XLII, Fig. 1.)

Precancerous Conditions.—That there are precancerous conditions is now generally admitted. The importance of recognizing these is only beginning to be fully appreciated. Mr. Jacobson mentions as precancerous conditions the bald tongue (the result of chronic glossitis, with destruction of the protective papillæ), ulcers, cracks, fissures, leucoplakia, warts, and old persistent glossitis, with numerous sulci and chronic enlargement of the organ. Continued irritation of these lesions is almost certain to lead to cancer. Just when the change takes place may be difficult or impossible to determine, but the importance of removing the irritation of jagged teeth and of avoiding the use of tobacco cannot be overestimated. Of the different precancerous conditions the most suggestive is a patch of leucoplakia with softening in the centre and warty outgrowths. This combination of conditions is an almost certain indication of the ingrowth of the epithelium between the papillæ and of the actual beginning of cancer. A better understanding of the nature and importance of these precancerous conditions should lead to the adoption of effective preventive measures.

If cancer is primarily a local disease,—and pathologists are fairly well agreed that it is,—and if in a very considerable percentage of cases there is a precancerous stage, we surely should be able to reduce the mortality caused by cancer of the tongue, and also to lessen the number of cases.

Etiology.—Sex.—Although cancer of the tongue is more frequent in men than in women, it is doubtful if sex has any influence in its determination. The precancerous conditions predominate in men. This is generally, and probably correctly, attributed to their more common use of highly seasoned and irritating foods, strong alcoholic drinks, and tobacco, and also to the fact that they more commonly exhibit evidence of oral syphilis. Different groups of cases give widely different percentages of men and women. If one estimates that women furnish ten per cent of the total number of cases of cancer of the tongue, this estimate will probably be approximately correct. The preponderance of carcinoma of the mouth in men is amazing. In a collection of 207 cases, 194 were in men and 13 in women, or 15 to 1, or men 94 per cent, women 6 per cent. Among 7 cases of cancer of the soft palate, 33 of the tonsil, and 14 of the pharynx, there was not one in which the patient was a female.

Age.—Cancer is essentially a disease of old tissues. The Imperial Cancer Research Fund has shown "that, both for carcinoma and sarcoma, increased frequency is manifested as life advances." This is a law common to all mammals,



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EARLY EPITHELIOMA UNDER THE LEFT BORDER OF THE TONGUE, APPEARING AS A FISSURE WITH PALE HARD BORDERS AND AN INDURATED BASE. (DR. ARMSTRONG.)

whether they are short-lived or long-lived. Even in the short-lived chorion "epithelioma appears at an interval after fertilization which corresponds to its senile stage of proliferation." It occurs in the castrated and spayed animals at the same age as in entire animals.

Cancer of the tongue is much more common after than before fifty. The greater number of cases occur between forty-five and sixty. Old age is not exempt. Striking exceptions are occasionally seen. Thus, Butlin has reported a case in a man aged twenty-four years, Hutchinson one in a girl nineteen; Variat has reported a case of epithelioma of the tongue in a boy aged eleven, Sigel one in a boy aged six, and Weber one in a man of one hundred. I have seen a typical epithelioma on the tip of the tongue in a man aged thirty-six; his mother died of cancer of the stomach. In these early cases there is probably, as Spencer and Butlin remark, a strong tendency toward the disease, hereditary or otherwise.

Social Status.—Cancer of the tongue is no respecter of persons. The poor are careless of their teeth. They visit the dentist only when they have the toothache. Their mouths are often in a most unwholesome state. In addition, they often smoke short hot pipes at all convenient seasons, and perhaps chew tobacco as well. Not infrequently they suffer from neglected oral syphilitic lesions. The wealthy as a class eat and drink too much, take too little exercise, suffer from various forms of indigestion, and have a furred tongue in which micro-organisms flourish.

Exciting Causes.—We do not know the cause of cancer. The parasitic theory is not proven. Gaylord and others have transplanted cancer in mice, and Sticker[10] has had some success in transplanting cancer of the generative organs of the dog; yet this does not prove that parasites are the infective agents.

"The process by which growing cancer cells are transferred to a new individual is easily distinguishable, and fundamentally different from all the known processes of infection. (Imperial Cancer Research Fund.) Acute trauma is seldom assigned as a cause of cancer of the tongue, but chronic irritation frequently repeated, such as that which is supplied by the ragged edge of a tooth, is apparently an etiological factor in many cases. It was observed by Ropke five times in sixteen cases of cancer of the tongue." On the other hand, cancer does not appear on every tongue that is irritated by a jagged tooth. These irritations would seem rather to be exciting causes, in presence of other unknown and predisposing conditions, in much the same manner as we too often see small neoplasms stimulated to activity by the application of caustics. A history of heredity is obtained in only a minority of the cases. In 210 cases of carcinoma of the tongue collected by Meller[23] from the reports of various authors, there was a history of heredity in 27, or nearly 13 per cent. One must remember here, however, that most hospital patients are woefully ignorant of their medical family history.

A predisposing cause would seem to be some altered nutrition, some lessened resisting power of the invaded tissue.

That syphilis is a cause of cancer is no longer believed, except in so far as it lowers the vitality of the part, and favors the occurrence of ulcers, scars, and patches of leucoma. Probably rheumatism and gout may act in a similar fashion. There is little doubt that the use of tobacco (either smoking or chewing) is a common cause of local conditions that predispose to cancer; and, when once a cancer is started, this use of tobacco serves as a daily stimulant to more rapid growth. Whitehead found sixty-one smokers among one hundred and four persons with cancer of the tongue. I have recently removed an epithelioma from the upper lip of a man, seventy-five years of age, whose occupation for years had been that of mixing a popular baking powder. This patient attributed the development of the new-growth to the irritation of the soda. He never smoked much.

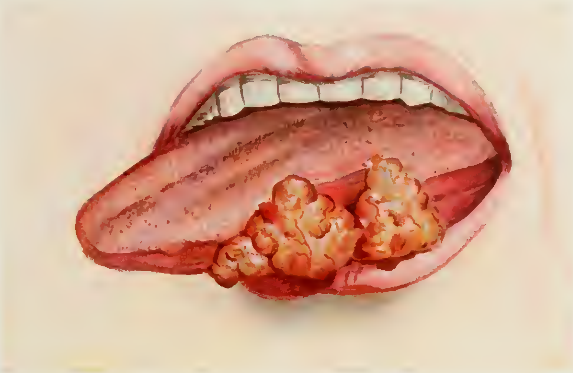
Course of the Disease.—The cancerous growth may begin in the superficial epithelium or in the mucous glands, particularly those in the region of the floor of the mouth. Thus, from their origin, we may divide the cases of cancer into the superficial and the deep. This division, however, is possible clinically only in the earliest stage. Later on, when the mass assumes some size, and the indurations become widespread, it is quite impossible to say—unless from the patient's history of the onset—whether it began on the surface or in the substance of the tongue. The predisposing surface lesions already mentioned (ulcer, fissure, wart, or leucoplakia patch) may remain in an indolent state for some time, and at first are almost certainly non-cancerous; at least this is true in many cases. The warty outgrowth is the most important and most frequent precancerous lesion; and, if not removed or destroyed, it will certainly become cancerous, if it is not really cancerous from the first. The early changes indicative of beginning malignancy are superficial ulceration, hardening of the borders, and induration of the base; the most important of these changes being the induration. If the cancer begins in a mucous gland, a nodule is the first palpable and visible sign. This may be felt in the substance of the tongue or underneath, in the floor of the mouth. It resembles a gumma. It is in these cases that the cancer is at first covered by normal mucous membrane. After a period of apparent latency, the disease advances, more tissue is invaded, ulceration deepens and spreads, induration increases, the tongue becomes fixed, the discharges are offensive, and the lymph nodes are enlarged. In the deep nodular form the overlying mucosa is destroyed, and an ulcer, or, very commonly, a fungating mass appears. When the destruction of tissue is considerable, in either the superficial or the nodular form, a crater-like ulcer may result.

In cases of long-standing superficial glossitis, due to syphilis and perhaps in some degree to tobacco, the epitheliomatous ulceration—the so-called "diffuse epithelioma"—has been observed over a large part of the surface of the dorsum.

EXPLANATION OF PLATE XLII.

FIG. 1.—Fungiform Carcinoma on the Side of the Tongue and Involving the Floor of the Mouth.

FIG. 2.—Tuberculous Ulcer on the Side of the Tongue near the Tip. Note the clean-cut edges of a brighter red than that of the surrounding mucous membrane.



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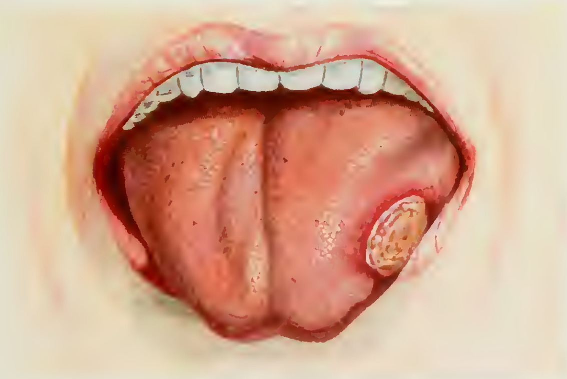

II.

CARCINOMA AND TUBERCULOUS ULCERATION OF THE TONGUE

(DR. ARMSTRONG'S CASES)

Cases have been reported in which there were two distinct patches of epithelioma on the tongue with an intervening area of healthy tissue.

The natural history of cancer of the tongue, when left entirely untreated, varies somewhat according to the situation of the initial lesion. When it is seated far back, the pillars of the fauces and the tonsils become involved, and the disease extends to the lymphatics and the parotid. The epiglottis and larynx may be invaded. When the lesion is seated farther forward, the floor of the mouth, the lower jaw, and the submaxillary region suffer most. The lymph nodes as far down as the clavicle attain considerable size, and sometimes break down, leaving deep excavations filled with necrotic, foul-smelling tissue which is prone to bleed. The involvement of the lingual nerve causes extreme suffering, the pain extending to the ear.* Hemorrhage is of rather frequent occurrence; it is often alarming, and sometimes proves fatal. The duration of the disease, in this case, was fourteen months—a rather longer period, I think, than the average. The limits are not less than five months and not more than eighteen months.

Locally, cancer of the tongue, like cancer of the breast, varies in accordance with the relative proportions of fibrous tissue and cells. The tumor is sometimes extremely hard and contracted like scirrhus, while in other cases it is softer and of greater bulk. The determining cause of these varying conditions has not yet been ascertained. The suffering, in the late stages of the disease, is extreme. In the course of time the tongue becomes so fixed that articulation is difficult, indistinct, and painful; salivation is profuse and constant; and mastication is impossible because the bolus of food cannot be controlled. Any but the blandest of foods causes distress. In addition to this pain and misery, the patients become weak and thin from lack of sufficient nourishment. Sleep is disturbed and unrefreshing. The foul-smelling discharges render him obnoxious to himself and his family. Death is due to exhaustion, sometimes mercifully hastened by hemorrhage or a friendly pneumonia. (Fig. 227.)

Involvement of the Lymph Nodes.—The researches of Kuettner and others have demonstrated that the lymphatic system of the entire tongue may be ininjected from any one section of the organ. Clinically it would appear that the flow from each half is toward the cervical lymph nodes of that side, and that the nodes of the opposite side of the neck are involved only when the disease approaches the median line of the tongue. In some instances both sides are affected, or only the side opposite to that on which the disease is located. Metastases to the lymph nodes always occur sooner or later. The nodes first to be infected are those nearest to the disease—the sublingual, the submaxillary, the submental, and the carotid, which latter node is situated at the division of the common carotid. Then, after these, the nodes which extend like a chain down to the clavicle and up to the base of the skull are involved one after the other. The submaxillary and sublingual salivary glands are involved by direct extension, the former often from the lymphatics contained within its capsule. There may be a simple inflammatory enlargement of the submaxillary salivary gland from pressure of the growth upon its duct, as in

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*In one case where the patient refused an operation, the facial nerve was partly paralyzed, and the pupil on the side of the disease became smaller than the other, from involvement of the sympathetic. The lymph nodes were found to be enlarged as far down as the clavicle. Largely as the result of the toxæmia, the patient became irritable and at times almost maniacal. During the last week of his life he was delirious; he gradually became drowsy and died comatose.

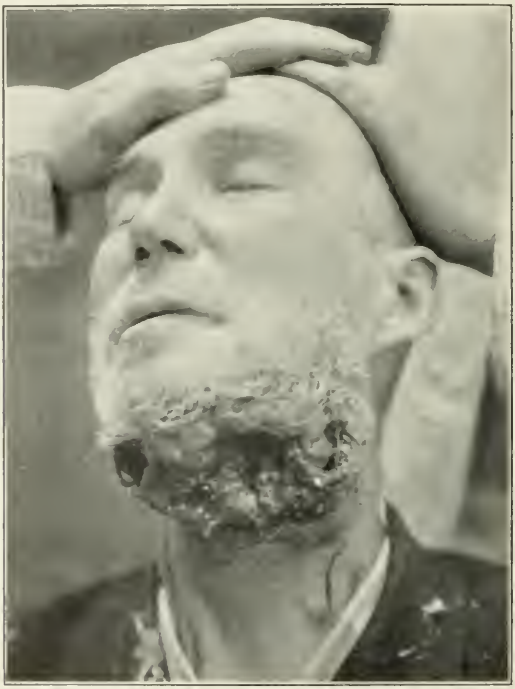

FIG. 227.—Illustrates the Breaking Down of the Submaxillary Gland in a Case of Carcinoma of the Tongue that Was never Subjected to Operation. The sloughing cavern-like ulceration is well shown. (Original.)

Butlin's and Bloodgood's cases of sarcoma of the tongue. The date of the enlargement of the lymph nodes varies. As a rule, it occurs early, within a few weeks; but there is evidence to show that occasionally it takes place later, only after the lapse of a few months. The early enlargement is probably due to metastases. The hygiene of the mouth is more seriously impaired later on, and then possibly the enlargement of some of the lymph nodes may be due to the infection resulting from this condition of the mouth. The differentiation between an inflamed and a malignant lymph node can be made with certainty only by examining small portions of the node with the microscope. Experience has abundantly proved that, for diagnostic purposes as well as at the operating-table, all the enlarged lymph nodes should be considered cancerous.

Metastases.—Metastases to distant parts are not common in cancer of the tongue, although in rare instances they have been found in the liver, the lungs, ventricles of the heart, mediastinum, sternum, and skin. Various reasons for this have been given. Patients with cancer of the tongue do not live long, and so there is scarcely time for the occurrence of metastases; then, besides, the cancer cells travelling by way of the lymphatics are generally stopped by the numerous lymph nodes, and it is not certain that squamous cancer cells lend themselves to grafting. It is now taught that cancer spreads by way of the blood stream more frequently than has hitherto been recognized; but clinically the evidence points rather to dissemination by way of the lymph vessels. It is a possibility that the cancer cells are destroyed after entering the blood stream. In one case of cancer of the left breast, where operation was refused, there developed symptoms which, in my opinion, as well as in that of my consultants, pointed quite clearly to a neoplasm in the right brain. Unfortunately, an autopsy could not be obtained.

Extension by Way of Muscular Fibres.—In considering the spread of cancer of the tongue, investigators have not given enough attention to metastases by way of the lymphatics, and certainly much too little to the spread of the disease into the extrinsic muscles of the tongue. This has been clearly demonstrated by Cheatle.[19] The hyoglossus lies immediately beneath the mucous membrane on the dorsal surface of the tongue, over the whole of its anterior two-thirds, and is commonly invaded when the cancer begins on the border. In advanced cases this muscle is extensively invaded. The disease also extends to the genio-glossal fibres of the genio-hyoglossus on the same side as that affected by the primary lesion. In rare cases the genio-glossal fibres of the opposite side may be invaded. The lingual muscle may contain secondary cancerous deposits near its attachment to the hyoid bone. The styloglossus is also commonly involved.

"The primary growth spreads in the muscles rather than in the fascial planes which separate them. The secondary deposits occur in the muscles and the fascial planes." (Cheatle.) The same authority points out that there is no mechanical reason why there should be limitations at the median line. The median raphe does not extend to the mucous membrane, and at the surface the communication between the lymphatics of the two sides of the mucous membrane is very free across the middle line. He thinks that the limitation at the median line and the freedom from involvement of the tip are due to lack of normal innervation, and that the disease is at least temporarily arrested at neighboring nerve areas. The points of coincidence in cancer, leucoderma, and scleroderma noted by Cheatle are certainly striking, and can hardly be fortuitous.

White's[20] investigation supports the view that carcinoma cells reach the muscles through the lymphatic vessels supplying these structures, since the lymphatic vessels so involved are usually localized in the connective tissue between the muscle fasciculi. The original metastasis first starts its growth from this situation. The sarcoplasma seems to offer a comparatively weak resistance to the carcinoma, and permits a rapid advance in a longitudinal direction; whereas the sarcolemma offers a comparatively high resistance to the carcinoma. White could find no evidence to support the view that carcinoma cells are carried directly to the sarcoplasma through openings normally present in the sarcolemma. When bundles containing isolated epithelial cells were found, it was always possible to trace these cells to a point where the bundle was lost in dense carcinomatous growth; that is to say, no islands of carcinomatous cells were found isolated from the main growth. The floor of the mouth is involved in one-third of the cases.

Diagnosis.—Cancer of the tongue has certain well-defined characteristics by which it may be recognized. The delays and errors in diagnosis are more frequently due to carelessness in observation than to ignorance of the features which characterize the disease. A fissure, wart, or ulcer, or a nodular mass that is located on the border of the tongue or on the floor of the mouth, that has an indurated base and hard borders, that is painful, tender to the touch, and sensitive to irritating foods and tobacco fumes, that is more or less immovable, and that is accompanied by salivation and by enlarged lymph nodes, is almost certain to be malignant if it is observed in a man of forty or over. (Fig. 228.) It is of vital importance to our patients that we recognize the true nature of the lesion, if possible, in its incipient or precancerous stage. It may be confounded with a simple ulcer or wart, a tuberculous ulcer, a syphilitic lesion, an ulcerating sarcoma, or a manifestation of actinomycosis.

A simple ulcer often has an obvious cause, and heals in three or four days after the cause is removed. If it does not owe its origin to an injury inflicted from without or to a burn, we may suspect that it has been caused by the jagged point of a tooth. In one instance I found a distinct wart on the side of the tongue opposite to a sharp corner of a broken molar. It was movable and, in four days after the tooth was extracted, the wart had disappeared. Simple ulcers, fissures, and warts lack that induration which is characteristic of epithelioma. Most valuable aid may be obtained from the microscope.

Tuberculous ulcers are not common on the tongue. When they are of a secondary character the presence of a tuberculous focus in some other part of the body should arouse suspicion of their nature. Primary tuberculous ulcers are extremely rare, and may cause very great difficulty in diagnosis. Nedopil's four cases of primary tuberculous ulcers were diagnosed as cancer, and as such they were removed. Tuberculous ulcers usually occupy the border of the tongue, and may be accompanied by enlarged lymph nodes. They often occur in individuals under thirty years of age; they are usually soft, with clean-cut edges; often they are of irregular shape and sinuous, and their color is of a more pronounced red than that of the surrounding mucous membrane. In some cases they are quite hard, and then the difficulties of diagnosis are greatly increased. Tubercle bacilli are seldom found, but particles of caseous matter may be seen, and tiny yellow points are observed in the surrounding mucous membrane. The microscope should at least demonstrate the absence of ingrowth and of the cell-nests of epithelioma.

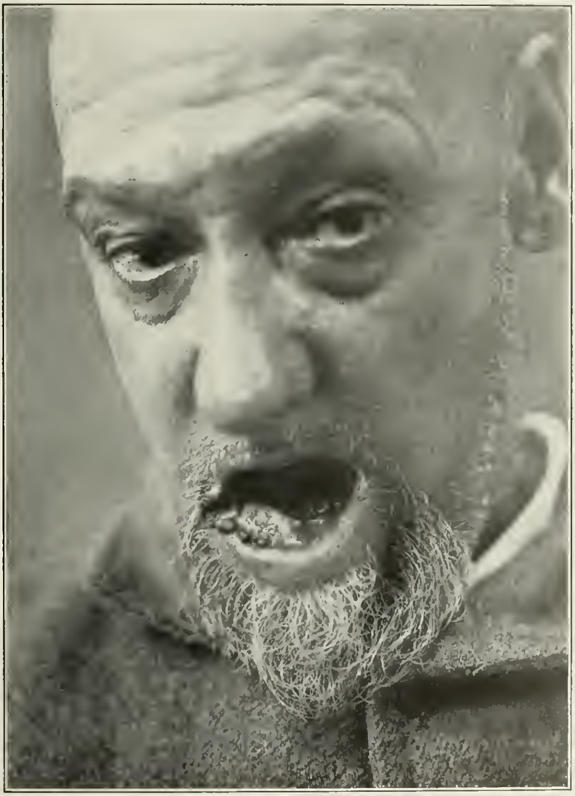

FIG. 228.—Carcinoma Developing in the Floor of the Mouth. (Original.)

Only the tertiary lesions of syphilis are apt to be confounded with carcinoma of the tongue. The secondary lesions seldom give rise to doubt as to their nature. Primary syphilitic sores are seldom seen; and, when present, they usually occupy the tip of the tongue. They occur in the young and are accompanied by a moderate enlargement of the nearest lymph nodes. They are as common in women as in men. Gummata and gummatous ulcers usually occupy the dorsum of the tongue. They are seldom seen on the borders of the organ or on the floor of the mouth. Quite recently, however, a man presented himself in my clinic, at the Montreal General Hospital, with a hard ulcerating lump on the left border of his tongue opposite to the molar teeth. It was very much like a cancerous nodule. He had a doubtful history of syphilitic infection. Suspicion of the syphilitic nature of the lesion was aroused by its bulk. A snipping showed none of the characteristics of epithelioma, and it disappeared entirely under antisyphilitic remedies. The base of a gummatous ulcer is more leathery, and the edges are often undermined. A nodule that has the appearance of a gumma, but that bleeds easily and spontaneously, is almost certainly malignant.

In tertiary ulcers of the tongue, the lymph nodes of the neck are sometimes enlarged, and so are they also in septic tuberculous ulcerations. The fact must also not be overlooked that the lymph nodes may be involved and yet not be palpable. They lie beneath the deep cervical fascia, and must attain some size and firmness before they can be felt. Before we obtain anything like the best possible therapeutic results, we must learn to diagnose cancer of the tongue without the aid of enlarged lymph nodes as a symptom. Early operation will give the same surprise here, in the matter of enlarged lymph nodes, as in the case of the breast and the axilla.

Gummata of the tongue do not as a rule cause pain. They are frequently multiple, and may be accompanied by other evidences of oral syphilis.

In actinomycosis the finding of the ray fungus will establish the diagnosis. In sarcoma the absence of the characteristics of epithelioma in microscopical sections will aid in making the necessary differentiation. A calculus lying in the floor of the mouth and surrounded by inflammatory tissue might simulate a malignant growth, but an exploring needle should dissipate the doubt. Each case should be carefully studied, and a diagnosis made at the earliest possible moment. When this is universally done by the family physician, who generally sees these patients first, our ultimate results in the treatment of cancer of the tongue will improve, and not before. I have never known any harm to result from snipping off a small piece of the growth. It is easily done and without pain. A pledget of cotton saturated with a twenty-per-cent solution of cocaine may be applied to the part, or a few minims of a four-per-cent solution may be injected beneath the suspected area. The latter method seems to me the preferable one. The tongue, enveloped in a piece of gauze, is then held forward and to one side by an assistant. The ulcer or wart is picked up with a pair of tissue forceps, and removed at one snip with a pair of scissors curved on the flat. It is very important to remove for examination a portion of the indurated area. Clinical or microscopical evidence of malignancy is sufficient to justify the local removal of the growth, but the whole or half of the tongue should never be removed unless the diagnosis is clear, both clinically and microscopically.

Treatment.—Operative treatment is the only treatment that should be considered. The early accounts of the surgery of the tongue are vague. An operable case is one in which the whole disease can be removed with a margin of at least 1 cm. of healthy tissue all around the tumor.

Until well on in the nineteenth century, cancer of the tongue was confused with a number of conditions, more particularly syphilis, lymphangioma, and gangrenous mercurial glossitis. Hippocrates showed great sagacity when he said: "It is better not to apply any treatment in cases of occult cancer, for if treated the patient dies quickly; but if not treated, they hold out for a long time." "All the ancient commentators explain that by occult may be meant either not ulcerated or deep-seated. The latter seems the better interpretation, and then the meaning would be that when the cancer is superficial, it admits of being removed by operation—that is to say, by the knife or the cautery; but when the disease is deep-seated, it is best to let it alone." It would seem that some of the earlier operations were done for non-cancerous conditions, particularly for lymphangioma, macroglossia, and gangrene, the result of mercurial glossitis. The early operations of the sixteenth century consisted for the most part in removing tumors from some accessible position, by means of the ligature, by cutting and burning. But little progress was made in the eighteenth century. In the early part of the nineteenth century ligatures and caustics were the two more common methods employed. The first distinct advance was made in 1819 by Langenbeck, who made a V-shaped incision and sutured the edges together. In 1827 Major applied a ligature to one half of the tongue after splitting it down the middle; later, came attempts to pass the ligatures below the jaw and round the tongue. In 1831 Jaeger divided the cheek to obtain better access to the disease in the tongue. In 1838 Regnoli removed the tongue through the floor of the mouth, through an incision made in the submental region. In 1839 Roux removed half the tongue with a knife after preliminary ligature of the lingual artery, and demonstrated the freedom with which it could be drawn out after division of the anterior pillar of the fauces and the attachment to the floor of the mouth. Sédillot in 1844 divided the lower jaw at the symphysis by an angular cut; then separated and removed the left half of the tongue just in front of the epiglottis. Three years later Syme, to whom this method is sometimes credited, removed the tongue after division of the lower jaw. For a number of years different forms of écraseur were used, chiefly with the object of lessening the danger of death from hemorrhage. I well remember, in my student days, seeing our professor of surgery remove the tongue with the écraseur, the first assistant standing by, watch in hand, for the purpose of determining when it was time to give the handle another turn. The mechanical écraseur caused great bruising of the tissues, and was not infrequently followed by very troublesome secondary hemorrhage and septic infection. The galvano-écraseur was thought to be an improvement. The great advance in the development of the present technique for the removal of the tongue was rendered possible by the introduction of antiseptic surgery. To Kocher more than to any other belongs the credit of emphasizing the importance of Listerian methods in the removal of the tongue, and of designing methods for carrying out this idea.

Before proceeding to describe the details of the different operations as practised to-day, there may be mentioned certain preliminaries which are applicable to all. One of the dangers, in cases of this kind, is a post-operative pneumonia. These patients, particularly those seen in our hospitals, enter the institution with the mouth, teeth, and gums in anything but a hygienic state. It is recommended by some to raise the opsonic index for streptococci before operating, thus increasing the patient's resistance to infection. Before the serious operation of removal of the tongue is undertaken, carious teeth should be removed and a mouth wash used freely for several days, until the mouth becomes as clean as it is possible to render it under the circumstances. The evening of the day before the operation, the patient should use the mouth wash very frequently and very thoroughly, and be allowed nothing but sterilized drinks out of sterilized cups from this time onward. With a view to lessening the danger as much as possible at the time of operation, it is important that in cold weather the body and the extremities be kept warm. The legs should be dressed separately in warm flannels, the arms thoroughly covered, and the body and chest kept warm and dry. After operation the patient should be placed in a part of the ward that is free from draughts of cold air. On the day following the operation he should be encouraged to sit up in bed with the aid of a back-rest, and to sit up out of bed for a short time during the morning and afternoon of each subsequent day. The upright position favors the clearing of the throat and mouth and lessens the danger of hypostatic and aspiration-pneumonia. Of the mouth washes that are most desirable, the following may be mentioned: a solution of potassium permanganate, 1 in 1,000, a saturated solution of boracic acid, and a solution of carbolic acid, 1 in 50, with a little sodium bicarbonate added. It is often well to keep these patients for a few days in the ward undergoing this preparatory treatment; they get good food, and become accustomed to the hospital régime before the operation is performed.

The operating-table for tongue cases should be one that can easily be made to change its position, and particularly to assume the Trendelenburg position. During the preliminary dissection of the swollen lymph nodes of the neck and the ligature of the lingual artery the patient may lie on a level table; but during the actual removal of the tongue from the mouth, more or less bleeding is inevitable, and it is therefore safer that he should then be in the Trendelenburg position, so that the blood, of necessity more or less mixed with the septic saliva and mucus in the mouth, may run into the vault of the pharynx, and be sponged out. The Trendelenburg position removes to a very great extent—in fact, almost altogether, if proper care be taken—the danger of aspiration-pneumonia. Butlin and Spencer speak very highly of the lateral position during this stage of the operation, in which position the blood runs into the hollow of the cheek and out of the mouth.

In this, as in other operations, each surgeon uses the anæsthetic which he likes best. My own preference in cases of this kind has been, for a number of years past, for chloroform, administered with a Junker's apparatus. The vapor of this anæsthetic agent is carried into the pharynx through an appropriately shaped metal tube that is passed along the floor of the nostril. The use of the Junker's apparatus permits the anæsthetist to stand at a convenient distance, to one side, and obviates the otherwise unavoidable delay caused by the necessity of suspending actual operative work until a fresh dose of the anæsthetic shall have been administered. The question of preliminary tracheotomy is one of importance, upon which there is a difference of opinion among surgeons of experience. In cases where the whole tongue is to be removed, with a part of the floor of the mouth, I am satisfied that the mortality resulting directly from the operation is lowered considerably by a tracheotomy or a laryngotomy, performed either just before the excision or a week or ten days earlier. I prefer the latter course. The advantages gained are that the epiglottis may be pushed over the laryngeal opening, and that the whole pharynx may be plugged so tightly that no blood can enter the trachea or stomach during the operation or while the patient is recovering from the anæsthetic. During the succeeding days the patient should be afforded all the fresh air that the ward or room is capable of supplying. If enlarged lymph nodes are to be removed from both sides of the neck, one side may be operated upon simultaneously with the tracheotomy, and at the same time the lingual artery of that side may be tied. The removal of the lymph nodes on the other side of the neck may be effected at the time when the tongue is excised.

Tracheotomy is not so essential where it is intended to remove only a portion of the tongue. When a considerable part of the organ is left, the hemorrhage is not so great; and besides, with the mouth in this condition, the patient has much more power to clear the cavity of the secretions that are so abundant and so annoying during the first week after the operation. Butlin has tried laryngotomy in a series of cases, and is pleased with the results. Laryngotomy may be better adapted to the requirements of the case than tracheotomy; but it is just possible that, if the tube is allowed to remain in the opening ten days or a fortnight, as is sometimes necessary, the vocal cords may experience some damage. If this fear proves to be unfounded, it is quite possible that in excision of the tongue laryngotomy may replace tracheotomy.

Two very legitimate questions are commonly asked by the patient: Will it be necessary to remove the whole tongue? and Shall I ever be able to speak again? In reply to the first of these questions the surgeon may make the following statements. If the disease is still in an early stage, and if it occupies only a small area at the tip of the tongue, the removal of the cancerous focus together with a zone of healthy tissue fully an inch broad, by a V-shaped incision, will probably confer upon the patient as great a degree of immunity as would be conferred upon him if a larger portion of the tongue were removed. If recurrence takes place, it will be in the lymph nodes rather than in the stump that the disease will manifest itself. The same reasoning applies in the case of early limited disease on the border of one half of the tongue. If that half is removed, one can get as far behind the disease on that side as if the other side were removed as well; and if the disease recurs, it will probably be in the lymph nodes rather than in the stump or remaining half. (Figs. 229 and 230.) Partial removal of the tongue should undoubtedly be confined to early, small, and favorably situated growths.

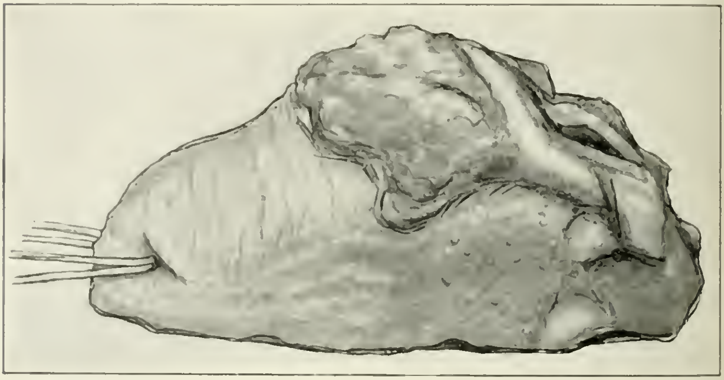

FIG. 229. Half of Tongue Removed by Operation for Carcinoma. The organ is lying upon its raw surface. The disease is located on the right border. The raw surface of the septum is not visible in the drawing. (Original.)

I am disposed to believe that hereafter these partial excisions will be done much more frequently than they have been in the past. The dividing line between cases suitable for partial excision and those in which the whole tongue should be excised is perhaps not easily drawn in the border-land group; and, of course, it is better to err on the side of wide and thorough removal than to subject the patient to the risk of any diseased part being left. The mortality in these extensive operations, undertaken when the disease is thoroughly established, is high, and it would seem as if it must necessarily remain high. Better results are to be obtained by the early recognition of the disease, and by its removal while the focus is still small and before the lymph nodes are involved. An article recently published by Butlin draws attention particularly to cases which, a few months ago, he would have considered precancerous, but in which the suspicious tissues removed by operation were found, upon microscopical examination, to be unquestionably cancerous. It is plain, therefore, that one cannot afford to wait for the so-called text-book symptoms of cancer of the tongue; one must learn to recognize its true nature before there is fixity, before there is involvement of the associated lymph nodes. The earliest conditions are recognized more by touch than by sight; they consist of a simple thickening of the surface, of small warty growths, not ulcerated or flat, or of very slightly raised, smooth, red, glazed plaques. These often represent, not a mere precancerous condition, but a genuine cancer in its early stage. A general removal of these suspicious lesions can hardly do harm; the operation leaves the patient with a good

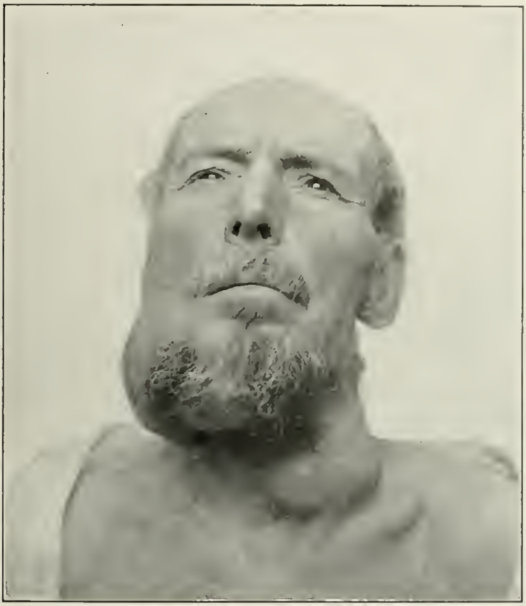

FIG. 230. Recurrent Carcinoma of the Cervical Lymph Nodes, Secondary to Carcinoma of the Tongue. (Original.)

tongue for speaking and swallowing. Many of us were brought up to believe that cancer of the tongue was properly and efficiently treated only when the whole of the tongue had been removed. The new doctrine would seem to be that we must strive to recognize cancer of the tongue when it is small and limited in extent, and while it may be sufficiently removed by a partial excision of the organ.

Great credit in the recognition of these very early cancerous conditions of the tongue is due to Dr. Bashford, the director of the Imperial Cancer Research Fund, and his assistant Dr. Murray. In the case of a man fifty-three years of age, who recently came under my care, there was visible, opposite the second molar tooth on the right side, a small fissure. It was visible only in a good light; but on palpation it was found to be hard and exquisitely tender, the latter condition being due to its proximity to the lingual nerve. I removed it, together with a margin of healthy tissue 1 cm. ($\frac{2}{5}$ in.) in breadth, and the pathologist of the hospital reported it to be undoubtedly a young carcinoma.

As regards the second question—Can I ever speak again?—it is an easier matter to give the patient a satisfactory reply. If either the posterior half or one lateral half of the tongue can be allowed to remain, the patient will have no material difficulty in speaking. If one lateral half is left, it soon comes to occupy the centre of the mouth, and is useful in mastication, swallowing, and speaking. When the whole tongue is removed, the floor of the mouth rises up, and supplies to a surprising degree the place of the tongue. Patients in this condition can speak more distinctly than can one whose tongue is the seat of a three-months-old cancer. A patient from whom, ten years ago, I removed the whole tongue as far back as the epiglottis, is to-day well and free from any sign of recurrence. During the past seven years he has earned his living as a book agent. One of his greatest difficulties at first was to masticate his food, and he was very proud when he became able once more to sit at the table with others and not excite attention.

A small growth on the tip of the tongue can be removed by a small V-shaped incision. No vessels of any size are divided. Ligatures will probably not be required, and the edges, brought together by a suture, will unite rapidly and satisfactorily. Small growths may be removed from the border of the tongue by a V- or crescent-shaped incision, and from the dorsum by an elliptical incision surrounding the growth. I am not aware that any series of specimens have ever been worked out with a view to determining how wide a margin of healthy tissue one should leave when making the incision for the removal of a malignant growth. A very common rule in literature is to cut at a distance of 1 cm. ($\frac{2}{5}$ in.) from the growth; in English books the proper distance is given as one-half inch. This would seem to be a minimum, but in early growths and in so-called precancerous conditions (possibly already become malignant), this would seem to be sufficient. One should not only cut sufficiently far back, but should carry the knife down sufficiently far into the depths of the muscle of the tongue, so as to get far below the infiltrated area. Before one undertakes to remove a small growth from the border or body of the tongue it is very important that the organ should be fixed and controlled; otherwise the field will soon become obscured by blood, and the operation rendered exceedingly difficult. A very satisfactory way of controlling the tongue is by passing through the anterior part two good-sized silk or linen thread sutures which may be used as tractors. The raw surfaces should be approximated and, as far as possible, retained by sutures, thus lessening the chances of infection, the suffering of the patient, and the period of repair.

When removing one half of the tongue, as in removal of the entire organ, I find it more expedient to begin with dissection of the lymph nodes of the neck. In the unilateral cases these nodes are removed, on the side corresponding to that of the disease, down to the level of the bifurcation of the common carotid. The submaxillary salivary gland is also removed, and the lingual artery is tied as it passes beneath the hyo-glossus muscle. In this way nearly the whole of the operation is done before the mouth is opened; and thus no blood during this time will have entered the larynx. Tracheotomy is seldom performed for unilateral excision. When the enlarged nodes have been removed and the lingual artery has been tied, the patient's head is thrown back, a mouth-gag introduced, and a bright light thrown into the mouth. Two strong silk or linen sutures are passed through the centre of the tongue, one on each side of the middle line. The mucous membrane is then divided longitudinally by a sharp knife, the incision beginning behind, at the point through which it is proposed to carry the transverse section—*i.e.*, about 2 cm. or three-quarters of an inch behind the posterior limit of the disease. The mucous membrane on the under surface of the tongue is next divided, and then the further separation of the two halves is effected by blunt dissection. After this has been accomplished it will be necessary, in order to separate the diseased half of the tongue completely from the parts to which it still remains attached, to divide the mucous membrane of the floor of the mouth posteriorly and the anterior pillar of the fauces, and then the root of the tongue (diseased half only) at the point decided upon. In a few cases there may be a little trouble with bleeding from the dorsalis linguæ or its tonsillar branch, but it is easily controlled. This part of the operation should be performed with the patient either in the Trendelenburg position or lying well over on the side corresponding to the diseased half of the tongue, so that the blood will collect in a pool in the cheek, rather than run back into the pharynx. In order to lessen the extent of the raw surface the mucous membrane of the remaining half may in certain cases be attached to that on the inner side of the alveolar process. The remaining raw surface is then painted with Whitehead's iodoform paint (see page 281), and a strip of iodoform gauze is packed upon the surface and changed twice daily, in order to keep the wound clean. If the disease has extended toward the floor of the mouth, the establishment of a communication between the floor of the mouth and the neck will be unavoidable. When such a communication has been made, every opportunity should be afforded for the discharges of the mouth to escape into the dressings on the side of the neck through a rubber tube half an inch in diameter, the upper end of which is just flush with the floor of the mouth. The upper and lower ends of the incision made for the removal of the enlarged lymph nodes may be closed, but at the centre of this incision the edges of the wound should be left gaping widely, as otherwise infection will be likely to spread along the cellular tissues of the neck.

Whitehead's Method of Excising the Tongue.—Mr. Whitehead[15] removes the tongue with a pair of strong blunt-pointed scissors; he finds no operating-table that, in his opinion, is equal to an ordinary high-backed rocking-chair. The patient is made fast to the chair by roller or jack towels, so placed as not to interfere with respiration. When secured, the patient can be raised from the horizontal to the upright position, or lowered to the horizontal or any intermediate stage at a moment's notice. Preliminary tracheotomy or preliminary ligature of the lingual artery is not in favor with Whitehead. His operation mortality is low: 3 deaths in 116 cases of total extirpation of the tongue. The first death (in a patient of fifty-six) was due to suffocation caused by the rupture of an abscess of the lung on the second day. The second occurred in a patient aged sixty-eight, who died on the twelfth day from syncope; while the third death was that of a patient aged seventy, who died on the fourteenth day from exhaustion after the floor of the mouth had quite cicatrized. The following are Mr. Whitehead's directions:—"Seize the tip of the tongue with a pair of forceps, pull it forward, and when it is in this position pass through it a strong ligature for the purpose of forward and upward traction during the operation. This is a most important matter, as the traction not only controls to a large extent the main artery, but it makes all the subsequent stages of the operation much easier. The tongue is drawn forward and upward to the fullest extent, and the frænum divided by means of a pair of scissors. The lower blade of the scissors is slipped under the mucous membrane on one side of the tongue, and run along this side as far back as the anterior pillar of the fauces. By closing the scissors, the attachment to the mucous membrane of the jaw is severed; the anterior pillar of the fauces and the lateral attachments are divided. The same procedure is, of course, repeated on the other side, when the whole tongue is to be excised. When these incisions have been made, it will be found that nearly the whole of the tongue can be pulled out of the mouth, making the remainder of the operation almost extra-oral; at any rate, so much so that there need be little fear of any blood getting into the air passages.

"Now, the more critical part of the operation commences, the one most dreaded by the inexperienced. Having proceeded so far in separating the tongue with the scissors, the timid surgeon need make no further use of a cutting instrument, if he wishes to avoid any risk of unintentionally dividing the artery. The tissues can be ruthlessly broken down and torn asunder. With a dry dissector he can break down the remainder of the friable tongue, and expose the artery and the nerves as clean as if he were making a dissection. Nothing is then easier than seizing each artery separately by forceps, snipping the distal ends, and gently twisting the stump of the vessel. The greatest confidence may be established by the almost universal certainty that if, after the forceps are removed, no immediate bleeding of the artery takes place, no subsequent hemorrhage need be feared. This, in my opinion, is an unanswerable argument in favor of torsion as against the use of the ligature, which some surgeons use in preference.

"Having twisted each artery, it is desirable, in my opinion, before proceeding further to place a loop of a strong ligature through the under and attached part or stump of the tongue, to prevent the stump falling back when the tongue is finally removed. That this is an advantage is denied by Sir Frederick Treves; but I still maintain that a ligature should be passed through the glosso-epiglottidean fold for the purpose of traction after the tongue has been excised, should secondary hemorrhage occur—a very remote contingency. In private practice it certainly affords the attendant nurse an element of confidence. In hospital practice the precaution is perhaps unnecessary.

"The final separation can be completed by either snipping through the remaining muscular fibres, or deliberately twisting the stump until the tongue becomes completely detached.

"After the tongue is removed and any small vessels still bleeding have been twisted, and when the floor of the mouth is quite dry, it is a great advantage from more than one point of view to apply a varnish to the floor of the mouth.[7]"

Whitehead's varnish is made by substituting, for the spirit ordinarily used in the preparation of "Friars' Balsam," a saturated ethereal solution of iodoform, turpentine being added to the mixture in the proportion of one volume to ten. It tends to check the oozing and to lessen the acute sensibility of the raw surfaces. The lymph nodes may be removed at the same time or at a subsequent operation. Whitehead reports one case alive and well thirteen years after he removed the tongue, and another twelve years.

Kocher, in his 1907 edition of "Chirurgische Operationslehre," advises against preliminary tracheotomy, and recommends that the affected lymph nodes be removed sixteen days before the removal of the tongue. He finds that when those located in the anterior triangles, as well as those lying underneath the sterno-mastoid and along the large vessels, have been thoroughly extirpated, the wound becomes too large and gaping; and, no matter what care be taken, it is almost impossible to prevent it from becoming infected. His normal procedure consists in dividing the jaw in the middle line (as first recom-

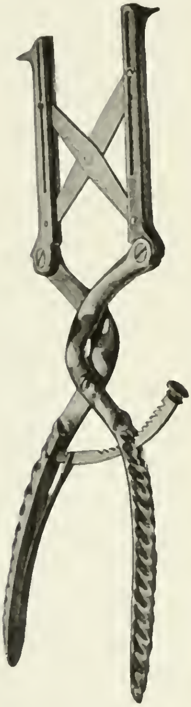

Fig. 231.—Forceps Adapted to Use in Keeping the Fragments of the Jaw Apart after the Latter Has Been Sawed Through. (After Kocher.)

mended by Sédillot) in all cases where the cancer extends as far back as the isthmus of the fauces, and where it has involved the arch of the palate, the fold passing to the upper jaw, the walls of the pharynx, and the soft palate. He claims the following advantages for this method: The hemorrhage is very slight, as it is more effectively controlled; the secretions of the wound are drained away much more satisfactorily; and the muscles of deglutition along with their nerves can be better preserved, thus insuring a better functional result and less interference with deglutition. An incision is made in the middle line through the lower lip down to the bone, and is continued as far as the hyoid bone, hæmostats being applied to the divided vessels in the lip. The jaw is sawn through in the middle line. It is a good plan to bore two symmetrically placed holes with a drill before sawing. The boring is to be done without reflecting the periosteum. It is advisable to saw obliquely backward toward the affected side, in order to keep the insertion of the genio-hyo-glossus and the genio-hyoid on both sides in the healthy part of the jaw. The two halves of the jaw are pulled a little apart, and the genio-hyoid and genio-hyo-glossi muscles are separated in the middle line if they are involved on one side. The two halves of the jaw are next widely separated by special forceps (Fig. 231), and the tongue is drawn out of the mouth and toward the healthy side by means of a loop of silk passed through it. The mucous membrane of the floor of the mouth is then divided in a backward direction, instead of from behind forward, as it is apt to tear close to the jaw if it is pulled on too much. This exposes the lingual vein running backward and outward, across the outer surface of the hyo-glossus muscle, and the lingual nerve passing forward close to the edge of the tongue, immediately under the mucous membrane. The hypoglossal nerve is seen crossing the outer surface of the hyo-glossus, and then passing forward toward the middle line to enter the muscular fibres of the genio-glossus. The lingual artery passes forward and upward between the hyo-glossus and the genio-hyo-glossus. It is clearly visible, and can be easily ligatured later. The hyo-glossus is divided, and, as in all muscular incisions immediately outside the limits of a new growth, is cauterized, a procedure which improves the prognosis by aiding in the complete removal of the disease. The tongue is then firmly dragged forward, and the mucous membrane far back is likewise divided with the cautery, well away from the tumor, if it has involved the palate and pharynx. The stylo-glossus muscle, which is visible, and the glosso-pharyngeal nerve lying beside it are both divided. By dividing the mucous membrane in front of the tonsil, the latter, even when invaded by the new growth, can be separated with a blunt instrument passed round its outer side, thus exposing the surface of the internal pterygoid muscle. As much of the soft palate as is affected is divided with the cautery, and the tensor and levator palati are cut through, the mucous membrane on the posterior wall of the pharynx being then divided down to the longus colli, and anteriorly to the root of the tongue. Lastly, the tongue is cut through, where it is healthy, with the thermo-cautery, and the nerves, muscles, and vessels (previously ligatured) are cut through on the under surface before they pass into the region of the new growth. The nerves and muscles are preserved as much as possible in order not to interfere with the mechanism of swallowing more than is necessary. (Fig. 232.) A thin layer of xeroform is rubbed into the cut surfaces. The two halves of the jaw are then approximated

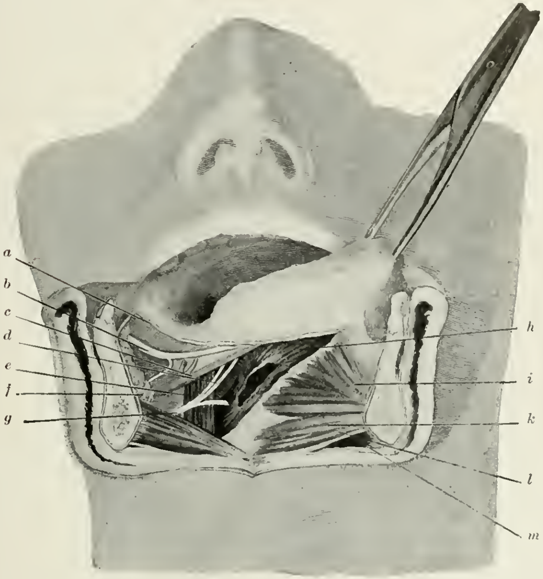

Fig. 232.—The Usual Method of Operative Procedure in Cases of Cancer of the Tongue when in an Advanced Stage. (Kocher.) *a*, Line of incision of the mucous membrane; *b*, lingual nerve; *c*, lingual vein; *d*, lingual artery; *e*, hypoglossal muscle; *f*, sublingual gland; *g*, hypoglossal nerve; *h*, right genio-glossal muscle separated from its place of attachment; *i*, left genio-glossal muscle; *k*, genio-hyoid muscle; *l*, mylo-hyoid muscle; *m*, digastric muscle.

and retained in position by strong silver wire; an opening is left for drainage a little above the hyoid bone at the posterior end of the incision. The patient is allowed to sit up next day, and may try swallowing a little tea or wine and water. Nourishment may be given through the stomach tube.

For the removal of the affected lymph nodes Kocher makes an incision beginning below the mastoid process and extending along the anterior border of the sterno-mastoid, and forward along the crease between the floor of the mouth and the neck, to the middle line; and, lastly, upward to the lower border of the jaw. In cases where the extent of the carcinoma is limited, a shorter incision—one corresponding to the middle two-thirds of the incision just described, that is, from the sterno-mastoid as far as the hyoid bone—will suffice. If the carcinoma has involved the floor of the mouth and the pharynx or the jaw, it is best to ligature at once the external carotid, after ligaturing the facial vein at the anterior border of the sterno-mastoid.

In cases of carcinoma situated at the base of the tongue, where the tumor is not accessible from the front—that is, in cases of cancer of the root of the tongue between the isthmus of the fauces and the hyoid bone—Kocher recommends a subhyoid pharyngotomy. The patient is anæsthetized, and a low tracheotomy is performed; the epiglottis is then exposed by the previously described incision through skin and muscles along the border of the hyoid bone. If the epiglottis is involved, the mucous membrane is divided along the upper border of the thyroid cartilage, the epiglottis is then hooked forward, and the mucous membrane on either side is divided. The finger is now passed on to the base of the tongue, and the mucous membrane of the pharynx beyond the disease is drawn forward and divided. If the disease has spread forward into the tongue, and especially if the hyoid bone is involved, the tongue should be split; the healthy muscles on its upper surface are then divided, and the deep cancerous infiltration of the tongue is reached and can be attacked from in front and behind. The lingual nerve, which is exposed on the lateral aspect of the tongue, should be divided if it is seen to enter the growth; if it does not enter the mass, it should be freed. The blood-vessels are to be treated similarly. The muscles and other tissues are then grasped with forceps and divided, so that the back of the tongue can be pulled into the wound and the organ divided transversely in front of the disease with the thermo-cautery. In this way Kocher has removed an extensive carcinoma which involved the whole base of the tongue, and had infiltrated the right wall of the pharynx and the epiglottis.

Methodical dissection of the lymph nodes of the neck is of the utmost importance. One can do better when one has a definite plan for working and possesses a clear idea of the location of the lymph nodes that are most likely to be involved, than when one simply goes groping about in the anterior triangle, removing any enlarged nodes that he may happen to come across.

The nodes that receive their supply from different parts of the tongue are the following: the submental, that lie upon and between the genio-hyoid and genio-hyo-glossi muscles, and that are more particularly involved in disease of the lower lip, tip of the tongue, and region of the frænum; the submaxillary group, one lying in the subcutaneous tissue over the submaxillary salivary gland, and the others lying beneath the gland and within its sheath; the superior carotid or parotid group, lying on or beneath the great vessels below and beneath the parotid gland; and the inferior carotid group, situated at the bifurcation of the common carotid. A lymph node that is situated at the posterior inferior angle of the hyo-glossus muscle should be looked for and removed. If the disease is in the middle line, both sides of the neck should be cleared out. Butlin removes the platysma. (Consult also the article on "Surgery of Lymph Nodes," in Vol. II.)

Butlin[14] recommends a long incision extending from the mastoid process, or from a point just below it, to the sterno-clavicular joint, along the anterior border of the sterno-mastoid muscle. Another incision is carried from the symphysis menti across the side of the neck to meet the first incision at a point corresponding to the upper border of the thyroid cartilage. It forms nearly a right angle with the first incision, and divides the skin into two large triangular flaps—a lower one, with its apex directed backward, and an upper one, with its apex turned downward. The lower flap is to be turned inward, and the upper one is to be reflected upward over the jaw. These flaps should be of skin only, or should contain very little more than skin, because, in addition to the lymph node that lies over the submaxillary salivary gland, there is another node in the submental region, one which also lies in the subcutaneous fat. These incisions give good access to the regions just indicated, and permit of a thorough cleaning out of the contents of the anterior triangle, at a minimum cost of time and with a minimum loss of blood. The submaxillary salivary gland, the lymph nodes, fat, connective tissue, a part of the omo-hyoid muscle, the platysma muscle, quantities of veins, sometimes a great piece of the internal jugular, if the lymph nodes are adherent to it, and sometimes a portion of the external carotid artery, should be removed.

When we remember that about seventy per cent of the recurrences are not in the scar, but in the lymph nodes, we can scarcely fail to realize the importance of making the regional removal of lymph nodes in carcinoma of the tongue as thorough as has been done in carcinoma of the breast.

A careful study of the various procedures suggested for the removal of the tongue, coupled with a moderate experience in tongue surgery, will make it quite evident that no one method of procedure can be followed, but that each case has its own individuality and requires a method of removal adapted to the locality and extent of the disease. It has been abundantly demonstrated that the anterior triangle of the neck should be cleared out in every case, independently of there being any evidence of enlargement of the lymph nodes. The fact that seventy per cent of the recurrences occur in the lymph nodes is sufficient evidence to establish this point. The writer has, for a long time, made it a rule to remove the contents of the anterior triangle through an opening made by means of two incisions—one that passes from the anterior border of the mastoid process down to the level of the upper border of the thyroid cartilage, and a second one that passes from beneath the chin and joins the first at about the level of the hyoid bone. (Fig. 233.) The flaps are turned, one up and one down, and the platysma, the veins, the lymph nodes, and the submaxillary salivary glands are all removed; special attention being paid to the upper and lower carotid and the submental regions. During this dissection the lingual artery may be very easily secured. After the submaxillary salivary gland has been turned up on the cheek, and the facial artery and vein have both been doubly ligatured and then divided between the ligatures, the posterior border of the mylo-hyoid muscle comes distinctly into view, while behind and beneath may be seen the hypoglossal nerve and the ranine vein, running along the surface of the hyo-glossus muscle. If the hyoid bone is then caught up with a strong blunt hook and steadied, an incision dividing the fibres of the hyo-glossus just above the hyoid bone will expose the lingual artery as it lies

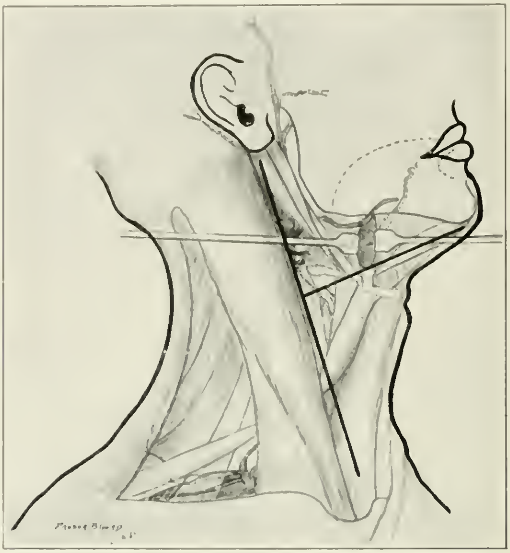

Fig. 233.—The Lines of Mr. Butlin's Incision. The lingual artery is also shown through the divided fibres of the hyo-glossus muscle. (Mr. Butlin has recently recommended the extension of the first incision down to the sterno-clavicular joint, to permit of more thorough search for infected lymph nodes.)

immediately beneath the hyo-glossus muscle. I have never failed to find it in this position.

If enlarged lymph nodes are found at the level of the bifurcation of the common carotid, the incision should be carried down along the anterior border of the sterno-mastoid to the sterno-clavicular joint. I always dissect the triangle of the neck before touching the mouth or even inserting a mouth-gag. If the case is one in which a tracheotomy is required, this is the proper time for the performance of this operation. The patients will thus be allowed a week in which to become accustomed to the tube, and the incisions in the neck will have sufficient time to heal before the operation on the tongue is undertaken. As already stated, the writer would perform tracheotomy or laryngotomy only in cases where more than one-half of the tongue is to be removed, or in cases where the disease is situated far back, and particularly where it involves the floor of the mouth. The operation (tracheotomy or laryngotomy) is in itself by no means a trivial affair, and may very well be dispensed with in partial resection of the tip or the side of the tongue, or even in the removal of an anterior or lateral half of the organ. If the patient's condition is good, and if a part only of the tongue is to be removed, the operation can be done very nicely after the removal of the affected lymph nodes is completed, and with very little additional loss of blood or additional shock. The patient is thus saved the ordeal of a second operation. In fact, I have nearly always completed these two separate operative procedures at one sitting. When the lymph nodes of the neck have once been dissected out, and after the lingual or the external carotid artery has been tied, the additional time needed for the removal of the tongue is trifling.

When the disease is confined to the border of the tongue, the floor of the mouth not being infiltrated, the half or the whole of the organ may be removed *per os*. There is then no direct communication between the mouth and the neck, and there is, therefore, no danger of the wound in the neck getting infected. If, however, the floor of the mouth has been opened, the neck may be protected, as mentioned before, by placing a large rubber drainage-tube (half an inch in diameter) in the wound, the upper end in the mouth being so placed that the orifice of the tube shall be just flush with the floor at its most dependent part, while the other end emerges in the neck. If the edges of the wound are carefully covered with Whitehead's varnish, and the wound in the mouth is dressed twice daily with the same varnish and covered with iodoform gauze, the wound in the neck will seldom become infected.

Trendelenburg drains the space between the tongue and the epiglottis by suturing the edges of the wound in the mucous membrane to the external skin near the lower angle of the incision. The plan seems to be a good one.

Professor Kocher's recent advocacy of division of the jaw in the middle line as a routine procedure in ordinary cases is one which does not commend itself to my judgment. When the disease involves the floor of the mouth, division of the jaw gives perfect access, and enables one to remove the disease with less interference with muscles and nerves than would otherwise be the case; and in such cases it is certainly the best procedure. If the disease, however, is far back at the root of the tongue, Langenbeck's operation, with division of the jaw at the angle, is far away the safer and more thorough procedure. If the jaw is divided either at the symphysis or at the angle, it should be done with irregular or rectangular cuts, as shown in the accompanying illustration (Plate XLIII), and without disturbing the genial tubercles. One can then, at the proper time, reunite the separate portions of the jaw with exactness. The holes for the wire should be drilled before the jaw is divided.

While Sédillot's or Langenbeck's method of dividing the jaw is advisable in disease involving the floor of the mouth or situated far back at the root of the tongue, such division is not necessary in disease of the tip and border. In fact, this interference with the jaw constitutes a compound fracture, in which there is an opening into the mouth; and very often the parts become infected and union is sometimes delayed.

In operating on advanced cases it is advisable, instead of cutting blindly at some distance from the actual cancerous growth, to identify the different muscles and to divide them at definite points—the stylo-glossus as high up as may be, the hyo-glossus and lingualis inferior at the hyoid bone, and the genio-glossal portion of the genio-hyo-glossus (on one or on both sides) near the genial tubercles. The lingual artery and veins, with their accompanying lymphatic vessels, should be removed. The branch of the hypoglossal nerve which supplies the genio-hyoid muscle, and which is given off about the centre of the hyo-glossus muscle, should be saved, if possible.

Patients with advanced cancerous disease of the tongue and enlargement of numerous related lymph nodes present themselves for treatment at our surgical clinics, and—as is still, unfortunately, too often the case—they give a history of having had the sore cauterized with nitrate of silver or other caustics, perhaps repeatedly for weeks. At the present day this is little short of criminal. Caustics cannot possibly do any good, and certainly do aggravate and stimulate the disease. Let us hope that the practice will soon come to an end. It is certainly hurtful to malignant sores, and often so to those of a simple nature.

After-treatment.—The after-treatment is important. Inspiration-pneumonia and exhaustion are the two great dangers attending extirpation of cancer of the tongue by means of the knife. When the patient is returned to the ward—or to his room, if the operation has been performed in a private residence—heat should be applied to the extremities. A nurse should be detailed for constant attendance during the first forty-eight hours. The patient's head should be turned to one side, and the mouth and pharynx kept as clear of mucus as possible. With care and gentleness they can be kept moderately dry and clear by the use of mops of sterilized absorbent cotton wrung out of an antiseptic

EXPLANATION OF PLATE XLIII.

Fig. 1.—Illustrates tortuous section through the lower jaw, the object of such a section being to secure perfect replacement and immobilization of the fragments by a single bone suture. The genial tubercles and muscular attachments are not necessarily disturbed in making this section.

Fig. 2. Illustrates the tortuous section at the angle of the mandible, in Langenbeck's operation One strong suture through the bone fixes the fragments firmly in position and retains them.

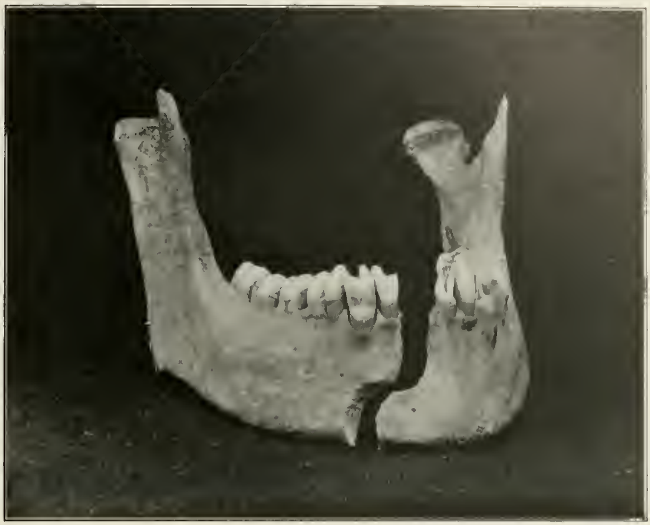

FIG. 1

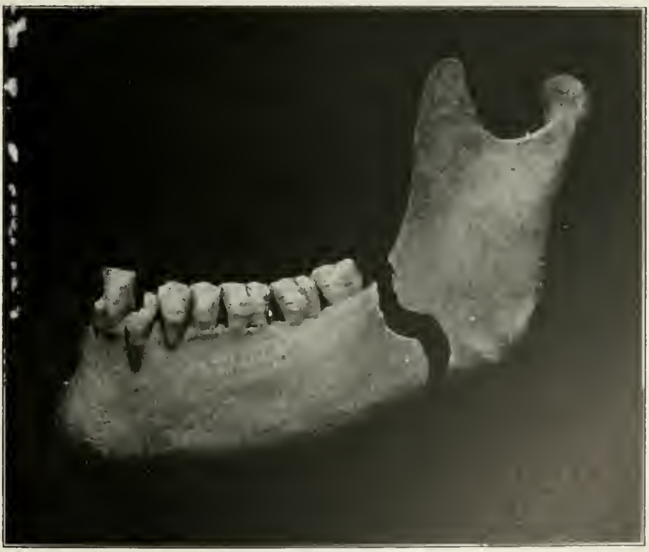

FIG. 2

Photographs Showing Tortuous Sections Through the Lower Jaw

solution. The next day the patient should be encouraged to sit up in bed with a back-rest, and to get into a rocking-chair for a while during the morning. On the third and following days he should be permitted to sit up in this manner during the afternoon as well. During the first forty-eight hours a nutrient enema composed of two ounces of peptonized milk, one ounce of beef juice, the white of one egg, and half an ounce of brandy should be given every six hours. A saline enema (ten ounces), administered every night and morning, is beneficial and relieves thirst. If swallowing on the third day is painful, the patient may be fed through a small stomach tube, or through a catheter passed along the floor of the nostril.

It may be possible, by Wright's method, to raise the opsonic power for staphylococci and streptococci. Emery did this in two of Cheatle's cases—for staphylococci only, in one, and for staphylococci and streptococci in one. The two cases did well, and the temperature remained normal throughout.

Operation Mortality.—It is very difficult to indicate fairly the mortality resulting from operations for cancer of the tongue. If a large number of cases, as published by the most experienced and skilful surgeons, are added together, the mortality will be found to be in the neighborhood of fifteen per cent. This is in some respects a misleading statement. The percentage given represents the results obtained by skilled specialists; it does not enable one to give a judicial reply to an inquiring patient.

Whitehead[15] reports 116 of so-called uncomplicated cases with 3 deaths, or a mortality of 2.5 per cent; but he had 17 deaths in a series of 38 complicated cases—a mortality of over 44 per cent, including 7 deaths in 9 cases of excision below the jaw (a mortality of 77 per cent). Improved technique is lowering the mortality-rate, but the bright outlook for the future is based upon an early diagnosis and upon the excision of precancerous and early conditions. Meller[23] finds recurrence in 79 per cent—radical cases in 14 (6 per cent)—and the operative mortality 13 per cent. It would appear that the longer time the disease has existed the greater the malignancy and the greater the danger from operation.

The mortality, after the removal, from the tongue, of cancerous nodules so small that the parts can be brought together with suture, very little, if any, raw surface being left, should be only what may be called accidental, *i.e.*, 2 per cent or less. The mortality after the removal of the anterior or lateral half should be well under 10 per cent; but, for the removal of the whole tongue, the mortality will possibly fall little short of 20 per cent or 25 per cent, and will be considerably greater when it is necessary to remove the floor of the mouth, a portion of the lower jaw, the tonsil, or a part of the pharynx.

End Results.—The best figures that I know of are Butlin's,[16] with 28 cures out of 113 cases, or 25 per cent. Meller[23] estimates the duration of life to be prolonged thirteen and a half months by operation.

TABLE SHOWING DURATION OF LIFE AFTER OPERATION FOR CANCER OF THE TONGUE.

	After one operation death occurred in:	One operation—death without recurrence:	Two operations—Length of time after the first operation when death occurred
1 operation, 30 cases 2 operations, 10 " 3 " 1 case 4 " 1 " 5 " 1 "	1 day, 1 case 2 days, 2 cases 7 " 1 case 15 days, 1 " 1 month, 1 " 2 months, 1 " 4 " 1 " 5 " 2 cases 7 " 1 case 8 " 2 cases 9 " 2 " 10 " 1 case 11 " 2 cases 12 " 1 case 14 " 2 cases 16 " 1 case	6 months, 1 case 19 " 1 " 6 yrs. 10 mos., 1 case Alive without recurrence: 6 yrs. 1 month, 1 case Well after: 5 yrs., 1 case 5 yrs. 2 mos., 1 case 6 yrs. 1 month, 1 case 7 yrs. 6 mos., 1 case	Well: 7 months, 1 case 8 " 1 " 10 " 1 " 12 " 1 " 21 " 1 " 2½ years, 1 " 4½ " 1 " 8¼ " 1 " 9¾ " 1 " Alive with recurrence: 3 yrs. 3 mos., 1 case 3 operations; death in 12 mos., 1 case 4 operations; death in 8 years, 1 case 5 operations; death in 4 yrs. and 9 mos., 1 case

With our increasing knowledge of precancerous and early cancerous conditions, and our improved methods of operating, can we not hope, in the very near future, to reverse the figures and get seventy-five per cent of cures and twenty-five per cent of failures?

Recurrences in the scar are generally hopeless. In one woman half of the tongue was removed for carcinoma in the Montreal General Hospital. Recurrence took place in the remaining half two months afterward. This half was then removed. Fifteen years later she was quite well and without recurrence. She is now sixty-one years of age. Any one can understand every word she says. Recurrences in the lymph nodes may be removed, when possible, and thus sometimes a respite is obtained.

The amelioration of the discomfort and suffering of patients affected with inoperable malignant disease of the tongue and mouth, or of patients who have refused operation, is not easily secured, and the results of treatment are usually unsatisfactory. Mouth washes may relieve the fœtor and salivation, and render these conditions less objectionable to those who come in contact with the patient. One of the least irritating and most effective is a solution of potassium permanganate, 1 in 2,000 or 1 in 1,000. The pain is constant night and day, and often severe, requiring increasing doses of morphia. Resection of the lingual nerve, first performed by Hilton, in 1850, to relieve pain in inoperable cancer, is a difficult operation in these cases, and has proved rather disappointing. Mastication becomes impossible, and swallowing difficult and painful. Any other than the most bland foods cause irritation. Milk and white of egg are among the best. These patients may sometimes be fed by a catheter passed through the nose, and nourishment may be administered by way of the rectum. Hemorrhages are not infrequent. They are sometimes controlled by pressure and by the use of astringents and adrenalin. If necessary, the lingual or external carotid may be tied. Lymph nodes which break down and suppurate are extremely offensive. The *x*-rays seem to hasten the breaking down, and are probably always useless in epithelioma involving the lymph nodes. They do sometimes relieve pain; one cannot, however, expect any recession from their use.

Whitehead[15] has found the relief of tension afforded by a linear incision to be very soothing, and advises it in suitable cases.

Sarcoma of the Tongue.—Our knowledge of sarcoma of the tongue is still somewhat vague and indefinite; the condition is rare. Marion, Shier, Keenan, and Naegele have collected and analyzed the reported cases. They are about thirty in number. There has been a great deal of criticism as to the cases included and excluded. The diagnosis is often extremely difficult, particularly when the growth is situated at the back of the tongue. It is doubtful whether the microscope, even when employed by the most skilful microscopist, can distinguish between a sarcoma at the base of the tongue and an inflamed lingual tonsil.

Marion excluded the small-celled tumors in which the cells were surrounded by a fine reticulum. This reticulum might be very easily overlooked if the small round cells were not first gotten rid of. Keenan included only 17 positive cases in his table. There is less difficulty in diagnosing sarcoma situated on the dorsum, the edge, or the under surface of the tongue. In Naegele's table of 30 cases, 5 were located on the back of the tongue, 7 at the base, 4 on the edge. The disease is rather more common in males than in females. Of Naegele's cases, three were congenital and rapidly assumed dangerous proportions. The so-called carcinomata of the tongue of cattle are chiefly due to the ray fungus.

Although a number of cases have occurred in infancy and in children under ten, the frequency of the disease seems to increase with age, and sarcoma, like carcinoma, would seem to be more common after, than before, the age of forty. In about fifty per cent of the cases the tumor is pedunculate.

Sarcoma of the tongue may be relatively benign, of exceedingly slow growth, and without involvement of the lymph nodes. A considerable percentage of these cases remain free from recurrence after removal. In another group of cases the tumor is desperately malignant, with early involvement of the lymph nodes, recurrence after removal being frequent, and the disease often developing again soon afterward. Congenital lymphangiectasis of the tongue has been known to precede the development of a sarcoma, and, in one instance at least, the tumor of the tongue has been secondary to sarcoma of the œsophagus.

Sarcoma of the tongue is generally accompanied by pain after a certain time has elapsed; ulceration and sloughing occur earlier in the rapidly growing forms. When the mass becomes necrotic, the resemblance to a broken-down gumma is very close. The diagnosis in these cases is very difficult to make, and can scarcely be made with certainty without the aid of the microscope. The superficial forms may be described as smooth and bulging on the side toward the surface of the tongue. In two reported cases (those of Butlin and Bloodgood) the submaxillary salivary gland was enlarged from pressure on its duct. The swelling of the gland subsided after the removal of the tumor. In 1903 I had under my care a case which illustrates very well the difficulty of making a diagnosis:—

A man, 47 years of age, who complained of a lump on the back of his tongue, was admitted to the Montreal General Hospital. This lump, he said, had been there for several months; that, a short time previously to his application for admission, he had been in another hospital, where a portion of the tumor had been removed; and that he had been told that the growth was a variety of cancer, and that his whole tongue would have to be removed. On inquiry at this hospital I learned that the diagnosis of sarcoma at the base of the tongue had been made. On examination, there was seen at the base of the tongue, in the situation of the lingual tonsil, a smooth, rather firm round tumor, which gradually merged into the pharyngeal tonsil on that side and was covered with normal epithelium. On two occasions portions were removed for microscopical examination; the pathologist of the hospital reporting, on each occasion, that he found no evidence of malignant disease. These sections were compared with those removed in the neighboring hospital and were found to be very similar. The pathologists of the two hospitals persisted in their respective, previously expressed opinions—on the one hand, that it was sarcoma, and, on the other, that there was no evidence of malignancy. The patient was a full-blooded, well-nourished man. While he was in the hospital I discovered, in the epigastric region, a hard, round, ball-like tumor, apparently the size of a large orange, freely movable, and seemingly connected with the walls of the stomach. Although urged to submit to an exploratory incision, the man absolutely refused. Some three months later, he returned to the hospital, and the exploratory incision which was then made revealed a large tumor, evidently malignant, involving and uniting into a single mass the stomach, duodenum, and pancreas. The tumor was irremovable. The man died in August, 1903, of general debility and malnutrition.

At the autopsy, the stomach tumor was found to be a round-celled sarcoma. The growth on the tongue, which had been considerably pared down by the taking of four pieces (two in each hospital) for the microscope, had never shown any sign of increase or return.

It may be argued that the growth in the abdomen was a metastasis from the tongue, and metastases are not uncommon in sarcomata of the tongue. It may be said, on the other hand, that the growth on the tongue was a metastasis from the abdomen. The microscopical findings in the small portions removed from the tongue were not sufficiently characteristic to enable the pathologists of the two hospitals to agree. The man lived eleven months after the tumor on the tongue was first noticed, and seven months after the four small portions had been removed, and during this period there had been no sign of growth at the site on the tongue.

It certainly is not characteristic of sarcoma to remain stationary after repeated irritation. It may be still a question, therefore, whether the growth on the tongue was a sarcoma or a hypertrophied lingual tonsil.

Prognosis.—The prognosis depends first on the character of the growth, whether it is comparatively benign and without involvement of the related lymph nodes, or of a more malignant type; but it may be said that, in cases where the disease has been recognized early and the tumor has been thoroughly removed, the prognosis is good. In the ulcerating forms, with enlarged lymph nodes, local recurrence and metastasis to the internal organs must be expected.

Treatment.—The treatment consists in removing the growth and the affected nodes as in carcinoma, and the same incisions may serve for both purposes. If recurrence takes place, Coley's serum should be given a trial. In fact, it may be employed with the object of anticipating a return of the growth.

Syphilis of the Tongue.—The interest in syphilis of the tongue centres chiefly in the tertiary lesions. A primary sore is occasionally observed; it is generally situated on the dorsal surface of the tip. It is more common in men than in women. It presents in a general way the usual characteristics of a hard syphilitic sore elsewhere. It may be an indurated superficial sore, a nodule more deeply placed in the subepithelial tissues, or a fissure located between the folds of the tongue. Phagedæna has been observed. Syphilis is contracted from smoking an infected pipe, from drinking out of an infected vessel (especially in Russia, where they are made of wood), by kissing, and by local contact in other ways. The disease can generally be recognized by its typical indurated base, which differs from the infiltration of carcinoma, and by the simultaneous enlargement of the related lymph nodes. In cases of doubt, one must wait for the appearance of secondary symptoms. The treatment is that of syphilis.

Soft chancre of the tongue has been reported, but it is extremely rare.

Mucous patches and papillomata are seen among the early, but much more frequently are found among the late, secondary manifestations of syphilis. They are far less common on the tongue than about the anus, vulva, or tonsils. Mucous patches are small whitish-gray spots, slightly raised; they are generally seen on the borders and dorsum of the tongue, and occasionally on the under surface. By the coalescence of several, a patch of considerable size may be formed. They sometimes persist for a long time (several months), if not treated. The secretion from them is contagious, and the patient should be warned about allowing any one to use his pipe. In this way the disease sometimes spreads among glass-blowers. These patients are a great danger to those with whom they live and work. The diagnosis is generally made from the appearance of the patches and the other evidences of secondary syphilis. The treatment is that of syphilis, and, in addition, the patches should be mopped daily with a ten-grain solution of chromic acid.

Fournier has described the occurrence of plaques and sclerosing glossitis in tertiary syphilis. The plaques, which are of an irregular round shape, are smooth, elevated, and generally multiple; they are placed superficially, and may fuse together. They occasionally ulcerate, and in healing they leave a scar or furrow. In other cases they disappear on treatment, leaving no scar behind them. The sclerosing glossitis is due to cellular hyperplasia, limited to the superficial portions of the tongue or extending into the deeper tissues. Superficial necrosis may take place, and, as a result, fissures may form. During the healing of the ulcerated areas the connective tissue contracts very considerably, thus causing at times deformity of the tongue. The diagnosis is generally evident from the association of the condition with other syphilitic lesions, and from a syphilitic history. The treatment consists in the administration of potassium iodide in increasing doses until the advance of the local disease is arrested. Additional relief may be afforded by wiping the tongue with a perchloride-of-mercury solution, 1 in 1,000.

Gummata may be divided into the superficial and the deep. Submucous gummata are small, the size of a pea or even smaller. They are generally multiple, are situated on the dorsum and borders of the tongue without any relation to neighboring teeth, and tend to break down and form small ulcers. Gummata occur in inherited and in acquired syphilis. The deep gummata are generally larger, and more centrally placed. The larger ones are sometimes formed by the coalescence of two or three smaller gummata. They are visible as projecting round bodies, and upon palpation they are found to vary in consistency. At first they are firm, and the mucous membrane over them is smooth. Although they remain quiescent for a considerable period of time, all gummata tend to disintegrate and break down, discharging a yellowish fluid. The base is often occupied by a ragged, tenacious, necrotic tissue, which shows, when pulled upon, very little tendency to bleed. Carcinoma, on the other hand, bleeds easily and sometimes spontaneously. The end of the tongue may be partly divided by the breaking down of a gumma and the subsequent contraction. Just before the overlying mucous membrane becomes perforated, a gumma may readily be mistaken for an abscess. Ulceration of the surface occurs not infrequently. The diagnosis can generally be made from the characters mentioned above and from the history. Gummata are very amenable to potassium iodide administered internally, which fact may ultimately establish the diagnosis. At Aix-la-Chapelle the use of hypodermic injections in conjunction with the iodide is found very effectual. Nobl uses injections of iodopin when the iodide is not well borne. Locally, it is important to keep the mouth thoroughly clean. This object is facilitated, and the healing is at the same time often hastened, by cutting or scraping away the necrotic tissue and by applying, to the surface thus left, chromic acid (10 or 20 grains to the ounce) or a carbolic-acid solution (1 in 20).

Recent investigation by Fenger, Neisser, and Williams would seem to prove that the living, growing border of a gumma is infectious.

The part played by syphilis in the etiology of cancer of the tongue has not yet been fully determined. There are surgeons of wide experience who think that cancer of the tongue is developed only in syphilitics. The consensus of opinion, however, is that syphilis is only effective in preparing a suitable soil. That the ulcers, scars and deep syphilitic fissures, and the nodes—which are really areas of normal tissue surrounded and rendered prominent by contracting scar tissue—are frequently the site of an epithelioma, is common knowledge. That syphilitic ulcers, scars, or leucoplakia patches are more liable to become epitheliomatous than other scars or patches of leucoplakia is not yet proved, and is not generally believed. It is certain that epithelioma of the tongue is seen in patients in whom there is no evidence at all of syphilis, either congenital or acquired.

Tuberculosis of the Tongue.—Tuberculosis of the tongue is most commonly observed as a condition secondary to advanced tuberculosis of the lungs, larynx, and pharynx. It occurs in the form of nodules, cold abscesses, ulcers, and fissures (so-called tuberculosis rhagades), and very rarely as lupus, not more than a dozen cases having been reported. The nodules are more commonly seen on the edge of the tongue; they are indurated, of moderate size, and tend to break down and leave an ulcer, sometimes with an undermined edge. Numerous small tuberculous nodules sometimes appear on the tongue; they subsequently break down and become small ulcers. The ulcers are superficial and occasionally multiple; the fissures are more like slits. Periods of quiescence and activity alternate. Temporary healing is not uncommon under suitable hygienic and climatic conditions. Tuberculous ulcers, even when fairly large, are usually superficial, and the tuberculous rhagades have soft edges. Secondary tuberculous lesions of the tongue generally occur when the patient is otherwise much reduced, and are the cause of salivation and of increasing difficulty in taking food, rendering the unfortunate patient's condition most pitiable. Fortunately, in a great majority of cases the epithelial covering is a sufficient protective against the frequent bathing of the surface with sputum containing tuberculous material. The lymph nodes are involved early. The tongue is sometimes involved from the spread of lupus from the face across the lips, and similarly the soft palate is affected through the spread of disease in the posterior nares. In secondary lupus the lesions of the tongue are nodules and elevated ulcers. In the more severe cases there is ulcerative destruction of the gums, with loosening of the teeth. When the disease is secondary to lupus, there is very little pain, and the lymph nodes are seldom enlarged. (Plate XLII, Fig. 2.)

Primary tuberculous ulcer of the tongue is rare. Frank and Hildebrand have collected a series of cases in which a general tuberculosis was traced to a primary lesion in the mouth. Chvostek has reported cases in which recent miliary tuberculosis of the lungs, kidneys, pleura, and meninges was preceded by chronic ulceration of the tongue. That a hæmatogenous infection sometimes occurs would seem possible; but, so far as I know, no actual cases have, up to the present time, been reported. Tuberculosis sometimes develops in the lingual tonsil.

When tuberculosis of the tongue is secondary to disease of the lungs and larynx, or to lupus, the diagnosis is generally obvious, because of the associated conditions. The ulcers and fissures, when secondary to pulmonary tuberculosis, are extremely sensitive, rendering it painful for the patient to speak or to swallow. Tuberculous ulcers are more common in men and in adults.

It is a very difficult matter to make a diagnosis of primary tuberculous ulcer of the tongue. An ulcer of this nature sometimes has a distinctly indurated base; and in fact excision has frequently been resorted to in the belief that the lesion was of a cancerous character. The close resemblance of the ulcer to actinomycosis and to epithelioma, as regards both external appearance and situation, is so great that it is often impossible to differentiate the one condition from the other. If the ulcers are multiple, this fact alone would prove a help, as actinomycosis and epithelioma are almost invariably represented by a single lesion. Fine tubercles around an ulcer suggest the diagnosis of tuberculosis. Tertiary syphilitic lesions are generally on the dorsum of the tongue, and syphilitic ulcers are much deeper and are surrounded by a larger infiltrated area. Syphilitic fissures also are deeper, more numerous, and quite irregular in outline. It might be almost impossible, upon a single examination, to differentiate between the tuberculous ulcer and an ulcer caused by a carious tooth. Tubercle bacilli can sometimes be found in scrapings from the ulcer; but, unfortunately, they are not very numerous, and may not be seen even after repeated examination. Animal inoculations, if successful, would demonstrate the nature of the ulcer. It is inexpedient to use the tuberculin test if the lungs are involved.

TREATMENT.—*Preventive Measures.*—It would seem obvious that infection occurs only under favorable circumstances and after the epithelium has been removed from a smaller or larger area. The experience of the unfortunate physician who accidentally inoculated his mouth with a cigarette that had been, a short time before, in contact with tuberculous sputum, would seem to bear out this view. The proper care of the mouth and teeth—an important matter under all circumstances—should receive special attention from the attending physician; and, if the tongue be kept free from injury by carious and sharp teeth and highly seasoned foods, the danger of local tuberculous infection will probably be very small.

Local Measures.—The treatment, in patients affected with a tuberculous ulcer of the tongue, consists for the most part in relieving the extreme pain and sensitiveness of the ulcerated area. This may be done by the local application of cocaine, eucaine, anæsthesine, orthoform, and iodoform. Spraying the affected area with a weak solution of carbolic acid (one per cent), to which a little sodium bicarbonate has been added, is sometimes soothing.

Primary tuberculous lesions should be excised. The results, in these rare cases, have been excellent. Great relief has been given by the excision of ulcers of considerable size, especially when they were single and favorably situated near the tip or on the border of the tongue, and even when secondary to pulmonary lesions. Under such circumstances it is important to aim at obtaining primary union by bringing the edges of the wound together with sutures, as otherwise secondary infection would almost inevitably take place.

The proper hygienic, dietetic, and climatic treatment is of the utmost utility.

Atrophy of the Tongue.—In 1863 Virchow pointed out a smooth atrophy of the glands at the base of the tongue in cases of late syphilis; the glands normally present in that situation being diminished both in number and in size. Potter[17] reports a study of more than 300 cases of various kinds. He finds that the symptoms present in about half of the patients indicate, in a fairly convincing manner, a syphilitic origin, while in about ten per cent of the cases the evidence of previous syphilitic infection is by no means satisfactory. The observations were made chiefly by palpation, as visual examination proved entirely untrustworthy. He concluded that when the papillary glands at the root of the tongue are normal, syphilis is probably to be excluded, while typical atrophy of these glands, in an individual below the age of fifty years, is indicative of syphilis. On the other hand, moderate or slight degree of atrophy is of little diagnostic value. Goldschmidt has found similar atrophy in tuberculosis and other debilitating conditions.

[For prosthetic appliances, see article on this subject in the present volume.]

III. SALIVARY GLANDS.

Injuries of the Salivary Glands.—The parotid, from its situation, is more frequently injured than any other of the salivary glands, and yet it would seem to bear a fair amount of handling—sometimes, indeed, rather rough in character—as so often occurs at the operating-table, when an anæsthetist, with one or both hands, throws the angle of the jaw forward. The more frequent injuries result from gunshot, blows, and punctures, and the importance of the injury is due more to the possible implication of important nerves and vessels than to the injury to the gland itself. This is particularly true with regard to the facial nerve. Incised wounds of the parotid are not of serious import. They not infrequently occur at the operating-table, and are seldom followed by fistulæ or even by any material retardation in the healing of the wound. In fact, the general oozing that takes place from a cut parotid so obscures the field of vision that one is not always sure that the gland is injured. If no infective material has been admitted, and if the wound is closed with fairly deep sutures, which obliterate dead spaces, any unpleasant results will be of rare occurrence. In one instance (a young woman), in which the submaxillary gland had been injured (in an attempt made to remove a tuberculous gland) some months before the patient came under my care, I had great difficulty in closing the salivary fistula which persisted, and which was apparently only glandular. Wharton's duct was free, and most of the saliva entered the mouth in the usual way. Pressure and the local applications of caustics failing, I succeeded in obtaining a complete closure by the excision of the fistulous tract and the approximation of the parts by deep sutures. Much more troublesome and vexatious, both to the patient and to the surgeon, are injuries that involve the ducts, and particularly the excretory duct of the parotid. A fistulous opening into Wharton's duct would probably be within the mouth, and consequently it would cause but little inconvenience. A few congenital fistulæ have been reported by Kuettner. He refers to Bochdalek's case, in which the opening into Wharton's duct was 11 lines behind the sublingual caruncle. In Ghérin's case (a young girl) two very small openings were situated 2 cm. above the sternum on the inner side of the sternomastoid muscle. Saliva exuded from these, and a colored fluid injected into the fistulæ appeared at the sublingual caruncle.

Surgical interest in salivary fistulæ is chiefly centred in those of the parotid duct (Stenson's) and its branches. A fistula persisting after injury to the parotid gland probably communicates only with one of the larger radicles of the duct. Here, however, closure can nearly always be effected by means of pressure, by the repeated application of silver nitrate, or by the Paquelin cautery. A fistula of Stenson's duct is generally the result of traumatism or disease, particularly the former. Blows, stabs, and gunshot wounds may result in a fistula leading to the duct, either directly or after suppuration has developed. Such a fistulous opening involves only a part or the whole circumference of the wall of the duct. The diagnosis is generally evident from the escaping glandular secretion, which is materially increased during mastication or as a result of irritation of the oral mucosa. Clean incised wounds of the duct doubtless often heal by primary union, particularly if only a part of the circumference is divided. If union does not take place then, a fistula remains which may either communicate with the mouth or discharge externally on the cheek. Fistulæ of Stenson's duct communicating with the surface are most distressing to the patient. The saliva constantly dribbles down over the cheek, and during mastication the flow is very free. Duphénix collected 70 grams in a quarter of an hour. Jobert's patient voided several cupfuls in twenty-four hours. Besides the annoyance experienced by the patient there is also a loss of a considerable quantity of an important digestive fluid. The constant flow over the cheek causes a most troublesome and conspicuous eczema, and practically excludes the sufferer from the table. Before instituting treatment or committing himself to a statement of the probable results, the surgeon should determine whether or not the peripheral portion of the duct is patent. In some cases the fistula shows a natural disposition to close, particularly when the buccal portion of the duct beyond the border of the masseter muscle is involved. Here a closure may sometimes be effected by the repeated application of silver nitrate to the fistulous orifice, and a fair trial should be given to this treatment, and a reasonable time allowed to elapse before the more serious measures are undertaken. If the peripheral end of the duct is patent, and there is only a wound in the outer wall, time and silver nitrate, or the point of a Paquelin cautery, will bring about a cure. If there is any narrowing of the orifice at the papilla, it may be overcome by splitting the buccal end of the duct. (See also page 443.)

Nicoladoni has successfully joined the ends of the divided duct after removing the scar tissue. When there is a considerable gap, he incises the cheek, picks up the end of the peripheral portion, and frees it from the buccinator up to the caruncle; then, by making a crescentic incision through the buccal mucosa in front of the caruncle, he is able to displace the duct orifice as much as 1.5 cm. ($\frac{3}{5}$ in.) toward the gland, and to this extent to approximate the ends of the divided duct.

If the existing conditions are not favorable for this plastic work, or if the patient objects to the inevitable scar resulting therefrom, an effort may be made to convert the external into an internal fistula. In the majority of cases, certainly in those in which the fistula is in the buccal portion of the duct, it is the method of choice.

Langenbeck carried the central end through an artificial opening in the mucous membrane. This plan, however, is not adapted to a short central end that would need to be carried through the masseter muscle.

Pearce Gould has found the following simple method quite satisfactory:—"A straight needle threaded with silver wire is passed into the fistula, and made to perforate the cheek into the mouth. The needle is then unthreaded and threaded on the other end of the wire, and again passed through the fistula, and into the mouth at a distance of about one-third of an inch behind the first puncture. The two ends of the wire are then drawn tight and twisted together. The tissue included in the loop is strangled and sloughs, and the wound thus formed into the mouth is free and without tendency to close." The external fistula heals at once. If the fistulous opening is over the masseter, the needles should be directed forward, over the border, and not through the muscle. If this fails, an attempt may be made to form a new canal, one that will be lined with the buccal mucosa.

In irremediable cases, it has been suggested to arrest secretion of the parotid by compression of the gland, or by ligaturing the duct. These attempts have met with indifferent success.

Sialoadenitis Acuta—Primary Acute Inflammation of the Salivary Glands.—The acute inflammations of the salivary glands may be primary or secondary. Mikulicz, Hernig, and Kuemmel refer to a rare form of inflammation of the submaxillary and sublingual glands which occurs in nursing babies during the first weeks of life. The glands swell, and pus may sometimes be expressed from the excretory ducts. Hernig thought that these inflammations might have some connection with puerperal diseases of the mother. Treatment consists in keeping the mouth as clean as possible and in draining any collections of pus that may have formed.

The parotid gland is the one chiefly involved in both primary and secondary inflammations. It is the most exposed to injury, and therefore to traumatic inflammation; and, with rare exceptions, it is the gland involved in that epidemic disease which is generally known as "mumps." In this disease, after an incubation period of from two to ten days, the gland swells and becomes painful, generally at first on one side only. The gland on the opposite side becomes involved when the inflammatory action and the swelling subside in that first affected. The course of the disease is attended by some fever. In from seven to fifteen days the swelling will have practically disappeared. Fortunately, suppuration is rare. The diagnosis is generally evident from the situation of the swelling, which extends forward over the ramus of the lower jaw and in front of the ear, as well as downward in the neck. In cases of suppuration, the condition may resemble Ludwig's angina. Little treatment is required except rest and the application of an ice-bag to the part during the first twenty-four or thirty-six hours. Afterward, hot fomentations are indicated. Fomentations of lead and opium are soothing.

The surgical interest in mumps attaches more particularly to the important complications in the testes and ovaries, particularly the former, and generally in those sexually mature. The process is one of orchitis, the epididymis and vas deferens not being involved. It generally occurs toward the end of the first week of the disease, and is attended by an accession of fever. According to Kocher, atrophy of the testicle affected ensues in one-third of the cases, and may be total or partial. In rare instances an apparently primary parotitis has been followed by a septic condition and cerebral symptoms. In a case recently under the writer's observation, a mild, almost unheeded inflammation of the parotid glands in an adult of mature years was succeeded, after an interval of three weeks, by an orchitis and a condition of septicæmia and albuminuria. The cause of mumps is unknown. There is accumulating evidence that it starts in the mouth as a stomatitis, the infection spreading along the duct to the gland itself. It is certain that in the prodromal stage a stomatitis is present. No very satisfactory explanation is offered for the complicating conditions—the orchitis and the oöphoritis. Bumm and Eisendrath thought there might be, between the salivary glands and the sexual organs, some nervous connection which would explain the complicating conditions in mumps, as well as the occurrence of parotitis after ovariotomy; but no such connection has been demonstrated.

Secondary Acute Inflammation of the Salivary Glands.—Greater interest attaches to the secondary inflammations of the salivary glands, and here again the parotid is the one more frequently and more particularly involved. The inflammation may be secondary to local conditions, such as calculi, bristles, or other foreign bodies in the duct; to stomatitis, particularly mercurial; but, more commonly, the inflammation is secondary to abdominal operations, and to a variety of diseases, among which typhoid fever occupies the first place. A great variety of septic conditions (*e.g.*, pyæmia) are occasionally followed by parotitis. The infection has been very generally thought to be hæmatogenous. Later investigations, however, have shown that in many cases there is a primary stomatitis with accumulation of viscid, bacteria-laden saliva, and diminished secretion through the duct—a condition favorable to the spread of infection from the mouth to the gland, just as, in typhoid fever with biliary stasis, infection may spread through the common duct to the gall bladder. The conditions obtaining in a long and tedious typhoid would certainly seem to favor the spread of infection through the duct. It probably cannot yet be definitely said that the infection always comes by way of the duct or that it is always due to metastasis. The submaxillary glands are occasionally involved. Klippel has observed degeneration in the gland cells, and catarrh of the excretory ducts in a patient suffering from tabes. In the surgical wards parotitis is more commonly observed in patients upon whom abdominal operations have been performed, such as ovariotomy and appendicitis. Thus the writer has noted the occurrence of a double suppurative parotitis in a young woman in whom he had closed a gastric perforation. The disease generally occurs toward the end of the first or second week after the operation. The development of swelling in a gland, surrounded, as is the parotid, by tense fascia, is quite painful. The swelling extends forward over the jaw and downward into the neck. The overlying skin becomes red and œdematous. In favorable cases the swelling subsides and gradually disappears; in others it increases and is followed by suppuration. There is radiating pain in the ear; the facial nerve may be paralyzed. Suppuration, associated with necrosis, occurs in a considerable proportion of the cases. If no outlet is afforded, the pus may burrow upward and burst into the external auditory meatus; it may also extend behind the pharynx or along the course of the vessels and nerves to the interior of the skull. Thrombosis of the jugular veins and sinuses has been observed several times. In some instances, although an early incision is made and a pocket of pus evacuated, the suppurative process will extend, and three or four days later the pus ruptures into the external auditory canal. When the submaxillary gland is involved and the inflammation goes on to suppuration, the resulting condition may simulate Ludwig's angina. The occurrence of a secondary parotitis sometimes contributes largely to a fatal issue. In the case previously mentioned (bilateral suppurative parotitis following closure of a gastric ulcer) the suppuration in the gland was clearly the cause of death. The repair in the stomach was perfect, and at the autopsy there was found no peritonitis. It was reasonably clear that death had been due to the pain and exhaustion from the suppuration and destruction of tissue in the two parotids.

TREATMENT.—As soon as the parotitis is discovered, an ice-bag should be applied over the parotid region, and the mouth should be carefully inspected. If a carious tooth is found opposite the opening of the duct, it should be removed. Antiseptic mouth washes should be used assiduously. Koenig recommends local applications of iodine over the gland. If the inflammatory action does not recede in from seventy-two to ninety-six hours, and especially if it shows a tendency to increase, and if the region becomes œdematous, an incision should be made over the most prominent portion of the œdematous area. This incision should extend through the capsule of the gland. Care should be taken to avoid the facial nerve and the large vessels. After the capsule has been incised, it is safer to enter the gland by means of a director, the opening thus made being gradually enlarged with a pair of forceps passed along its groove. The suppurative foci are sometimes multiple, and although one, and perhaps the largest, may be evacuated externally, others may extend into the ear, into the mouth, down the neck, or into the retro-pharyngeal space.

Sialodochitis, or Inflammation of the Excretory Duct.—An inflammation of the excretory duct of the parotid gland may occur alone, without involvement of the gland; the inflammatory swelling being sufficient to occlude the duct and cause salivary retention. The condition is generally relieved by heat. In obstinate cases, the introduction of a sound into the duct at intervals is said to give satisfactory results. If the orifice should become occluded from fibrous thickening, it may be necessary to slit open the terminal portion of the duct.

Chronic Inflammation of the Salivary Glands.—Professor Kuettner has described a series of cases of chronic inflammatory tumor involving the submaxillary glands. In these cases the gland became enlarged to the size of a hen's egg or an apple, and elongated in shape. He thinks that other salivary glands might be involved in a similar process. The tumors, which are the result of a chronic interstitial inflammation, are tender and sometimes contain foci of granulation tissue and minute abscesses. They tend to enlarge steadily, and to become adherent to the surrounding tissues. They resemble, clinically, a sarcoma or a malignant mixed tumor. In fact, Kuettner, when removing the glands in his early cases, felt sure that he was dealing with a sarcoma. Microscopically, they were made up of connective tissue, and in places there was an infiltration of small cells. When the disease involves the submaxillary glands, removal is the only treatment. This course is advised because of the tendency of the inflammation to spread more and more into the surrounding tissue, and because of the difficulty of differentiation between such a chronic inflammatory tumor and a malignant neoplasm.

Actinomycosis.—The salivary glands are rarely affected primarily by the actinomyces. (See Vol. II., page 55.)

Tuberculosis of the Salivary Glands.—There have been recorded 10 cases of tuberculosis of the salivary glands—9 of the parotid, and 1 of the submaxillary. (Kuettner.) The patients varied in age from thirteen to sixty-one, and presented no other tuberculous focus. The diagnosis is exceedingly difficult. If, in a given case, the suspicion should arise that the condition is one of a tuberculous nature, the tuberculin test might be employed to confirm the diagnosis; otherwise it would probably be impossible, unless a cold abscess or a chronic sinus with undermined edges should develop, to differentiate a tuberculous from a malignant or other form of tumor of the salivary glands. In the cases so far reported, removal of the affected gland has not been followed by results of a very satisfactory character. When the submaxillary is the gland affected, total removal is the proper treatment; but in the case of the parotid gland partial extirpation may alone be practicable. If a cold abscess develops, drainage will have to be established.

It should be borne in mind that in some of these cases the facial nerve may be implicated.

Syphilis of the Salivary Glands.—Syphilis of the salivary glands is also rare, not more than twenty or twenty-five cases having been reported. Any of the glands may be involved, and occasionally several are affected at the same time. Gummata may be present, or there may be an interstitial fibroid change. The diagnosis is possible only in the presence of other manifestations of syphilis.

Mikulicz's Disease.—Mikulicz has described a symmetrical enlargement of the salivary and lachrymal glands. Other observers have added: associated enlargement of the palatine gland and swelling of Blandin-Nuhn's glands (Kuemmel); hypertrophy of the labial and buccal glands; general swelling of the lymph nodes of a moderate degree; and a palpable enlargement of the spleen (Osler). The glands generally involved are both parotids, the submaxillary, sublingual, and lachrymals. The condition is sometimes more evident on one side, and the different glands may be involved and affected to a variable degree. The parotids have attained sizes varying from that of a goose's egg to that of a fist, and other glands have been found increased to twice their natural size. The enlarged glands are firm, not tender, and not infiltrated. They may interfere with mastication and speech, and are conspicuous. They are more closely allied in nature to the malignant lymphomata. The prognosis is favorable, so far as life is concerned. Arsenic and potassium iodide have been found of service. Extirpation is required only when they cause disfigurement and functional disturbance.

Tumors of the Salivary Glands.—The salivary glands not only suffer from the pressure of neighboring growths and from the infiltration which they cause, but they themselves serve as seats for the development of a variety of epithelial and connective-tissue tumors. The parotid is the gland most frequently involved, and the so-called mixed tumor is found here more frequently than is any other form of new-growth. The origin of mixed tumors is still somewhat uncertain. Kaufmann and others regard them as endotheliomata, while Wilms and Hinsberg find in them evidences of epithelial and connective-tissue origin. Verhoeff thinks that the mixed tumors of the lachrymal and salivary glands (so-called endotheliomata) are essentially epiblastic in origin, and that the stroma is not derived from mesoblastic cells misplaced from other structures, but is probably produced by an atypical development of cells which ordinarily would have formed part of the stroma of the normal gland. F. C. Wood concludes, from the study of a large number of cases, (1) that mixed tumors of the salivary glands contain elements from both epiblast and mesoblast in most intimate relation to each other; (2) that the fact that the stroma contains elements such as embryonic connective tissue, cartilage, bone, fat and lymphoid tissue, and, very rarely, striated muscle, is explained most easily by the assumption of an embryonic misplacement of mesoblast; (3) that in twenty-four per cent of the tumors examined the presence of epithelium is undoubted; (4) that the theory of early embryonic displacement of epiblastic tissue during the process of formation of the parotid and submaxillary glands and the branchial arches may account for many of the morphologic peculiarities of the cells of these tumors, especially the lack of many typical features which we associate with epithelium; (5) that the clinical history is strikingly different from that of sarcomata and carcinomata, in that they are slow-growing and generally benign. Recurrences are likely to remain local in a considerable proportion of the cases. Mixed tumors of the parotid region sometimes attain a great size. Keen removed successfully, from a male aged forty-nine, a mixed tumor that weighed four and three-quarter pounds. It extended down to the clavicle and nearly to the median line at the back of the neck. In twelve years it had become as large as a walnut. It then grew rapidly for a number of years, and, in the two years preceding its removal, it had doubled in size. It was examined by Caplin, who pronounced it a myxo-chondro-lymphangio-endothelioma. Koenig has found these mixed tumors more common in the second decade, while Kaufmann, from the study of a small number of cases, found the greatest frequency in the third decade. Cases, however, have been observed in the first year of life, and Koenig removed an enchondro-sarcoma from a man sixty-eight years of age. The Roentgen-rays are sometimes useful in the treatment of inoperable and recurrent mixed tumors, and should be given a faithful trial.

While mucous tissue, carcinomatous, sarcomatous, and cellular portions, and inclusions of cartilage are found in these mixed tumors, the sarcomatous element would seem to predominate in a large percentage of cases. Pure sarcoma (and particularly a round-celled sarcoma) has very seldom been observed in the submaxillary or parotid gland. Spindle- and round-celled sarcomata vary in size, but are seldom larger than a hen's egg. Fibrous sarcomata are larger;

they present hard and soft areas. On section they are white or yellow, or reddish-white. Myxo-sarcomas are sometimes as large as a child's head. Chondro-sarcomata vary in size, the smaller ones being very hard, and the larger ones softer. A pure enchondroma has not yet been observed in the parotid gland. All these forms are encapsulated. By far the larger number of tumors of the parotid develop from connective tissue, and are of the nature of sarcoma. According to Billroth, about three-fourths of the parotid tumors are of this class and the greater number of the remaining fourth are carcinomatous. They assume mostly a round shape. Chondro-sarcomata are uneven and nodular. Their consistency varies, but they are for the most part hard. The presence of considerable mucous tissue gives rise to a pseudo-fluctuation.

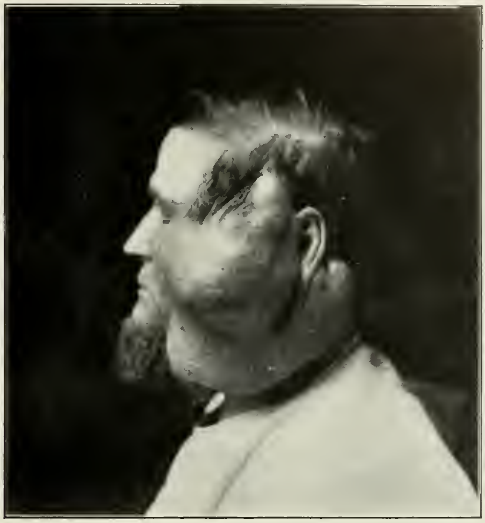

FIG. 234.—Mixed Tumor of the Parotid. Successfully removed. (Original photograph in the McGill Museum.)

The situation of a parotid tumor varies somewhat. It may press up against the ear, may extend down into the neck, or may appear in front of the ear, particularly when arising in the socia parotidis. These tumors are of exceedingly slow growth. After being present and increasing slowly for years, they may suddenly take on active growth, with or without changing their character from one of comparative benignity to one of malignancy. In some instances this change has followed a local injury. Tumors of the submaxillary gland occasionally push up the floor of the mouth, but more generally they appear as a growth in the submaxillary region. As a rule, the overlying skin is not adherent, and the tumor is movable over the tissues beneath. There is no tenderness on pressure; annoying salivation is sometimes present. If it is very large, and if it is growing toward the mouth and pharynx, the tumor may interfere with speech or swallowing. When growing upward, it may diminish hearing, by compressing the auditory meatus. Facial paralysis is rare and is rather indicative of malignancy, although it is occasionally due to the direct pressure of a benign growth. (Figs. 234, 235, and 236.)

The diagnosis of either a parotid or a submaxillary tumor is not difficult, when the situation occupied by the growth is typical. One should hesitate in diagnosing as a tumor of the parotid one that does not overlap the jaw. The consistency varies. In some, a pseudo-fluctuation may cause a great resemblance to a cyst; so much so, that an exploring needle may be required to determine the true condition. A lipoma should be recognized by its situation and consistency. From lymphangiomata the differentiating diagnosis is very difficult. A single large tuberculous lymph node sometimes resembles very closely a tumor of the parotid; so also does a single large lymph node in Hodgkin's disease, although here a careful search will probably find other enlarged lymph nodes in the axillæ or the groins.

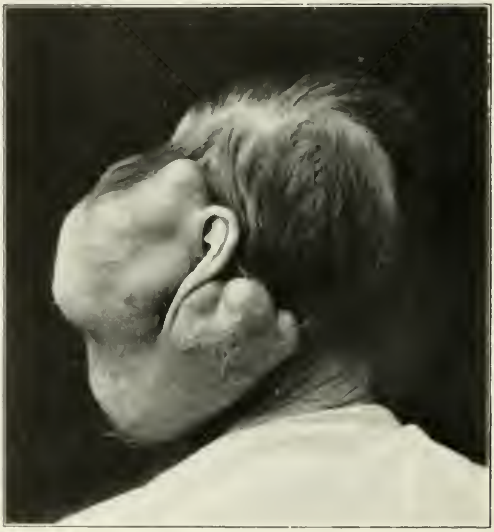

FIG. 235.—Mixed Tumor of Parotid. Posterior view of tumor shown in Fig. 234. (McGill Museum.)

In the encapsulated tumors the prognosis, as a rule, is good. Radical removal is indicated. Recurrence takes place in about one-third of the cases. The mere fact of a recurrence is not proof positive of malignancy, as it may be due to a growth from some portion of tumor or capsule left behind at the operation. Metastases are infrequent, and, when they do occur, are more common in the lungs. The lymph nodes are rarely enlarged in mixed tumors.

Patients seldom apply for treatment until the size of the growth has caused disfigurement, or until symptoms of pressure have developed. The only treatment to be considered is the removal of the growth. When it is situated in the submaxillary gland, it is better to remove the tumor and the gland together. Early operation should always be advised, not only for the relief of the symptoms present, but because of the danger of the growth changing its character, even after years, and becoming malignant. Tumors of the parotid are sometimes more difficult to deal with, particularly when they are deeply situated. The incision should be made in the direction of the facial nerve. The tumor and the whole of the capsule should be removed. If any portion of the capsule is left, recurrence of the growth will in all probability take place. Great care should be taken to avoid injury to the facial nerve after the capsule is exposed. A great deal can be done by blunt dissection, and the nerve fibres, as they appear, should be pushed to one side.

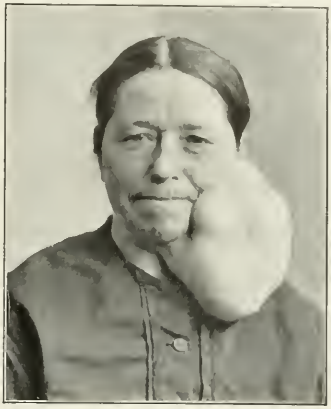

Fig. 236.—Mixed Tumor of Submaxillary Gland. (Original photograph in the McGill Museum.)

Facial paralysis would be rather a severe penalty to pay for the removal of a non-malignant growth which may not be incompatible with comparative health for years to come.

Hæmangiomata and lymphangiomata have been observed in the parotid. The diagnosis of a lymphangioma is likely to be very difficult. A history of recurring inflammatory attacks, each followed by a persistent increase in the size of the tumor, would be suggestive. An angioma of the parotid should be clearly differentiated from a nævoid condition in the overlying tissues. True angioma, involving the gland tissue proper, is rare. Hartmann, Koenig, and Bidone have reported cases in which the tumor has been successfully removed by operation, and Boeckel has also reported the successful removal of one in the submaxillary gland.

Fatty tumors are found just within the capsule and growing in the substance of the gland. A lipoma, or more rarely a cyst, developing in the substance of the gland may readily give to the latter the appearance of being simply hypertrophied. True hypertrophy of the parotid gland, however, has never been observed. Prudden reports a case of rhabdomyoma of the parotid; it occurred in a boy. The occurrence of a pure myxoma of the parotid must be considered doubtful; the cases so considered being probably instances of mixed tumors with mucous tissue predominating.

Of the epithelial tumors arising in the salivary glands the most frequent and by far the most important is carcinoma. Adenoma undoubtedly occurs in the parotid, submaxillary, and sublingual glands. Nasse has reported four cases of pure adenomata of the parotid that were encapsulated. It is probable, however, that many of the tumors reported as adenoma have been in reality mixed tumors. Carcinoma of the salivary glands may be primary; may occur as a metastasis from the tongue or jaws; or may appear in a slowly growing tumor that has been latent for years and then has suddenly, with or without known cause, given evidences of malignancy.

Cancer of the parotid may assume any of the forms found in carcinoma of the breast; and, according to Koenig, the soft cancers, rich in cells, are the more common, the growth bursting through the capsule and infiltrating the lymphatic and the surrounding tissues. As elsewhere, this medullary form of carcinoma is rich in vessels and very malignant. It breaks down easily, forming a deep cavernous sore which is prone to bleed. In other cases, the carcinoma develops in the small ducts, and in consequence the growth proceeds in the form of long tubes lined with cylindrical epithelium. At the end of the tubes are epithelial-like pearls and warty excrescences which project into them from without.

O. Weber draws an analogy between this form and the cystosarcoma phyllodes of the breast. The scirrhus form of carcinoma is also found in the parotid. As in the breast, the tumor here is of slow growth, causing atrophy and shrinking of the tissues of the side of the neck and of the parotid region. Cancer of the parotid, as of other regions, occurs generally after the age of forty. The soft medullary forms, however, are sometimes observed earlier in life. In these forms the lymph nodes are involved early and increase in size rapidly, frequently forming of themselves tumors of no inconsiderable size. The facial nerve, in the growths of this variety, often escapes for a long time. The clinical history of scirrhus, on the other hand, is that of an exceedingly slow growth, with late involvement of the lymph nodes. In this form of tumor, however, the facial nerve, or some of its branches, seem to be involved early from pressure and cicatricial contraction. The neighboring skin, as in scirrhus of the breast, may become hard and indurated, resembling cancer *en cuirasse*.

Carcinoma of the parotid sometimes involves the cheek, and at other times extends into the pharynx or down into the neck. By pressure, it may interfere with swallowing, mastication, and speech, and severe radiating pains may extend into the ear, over the face, or into the front and back of the neck. The prognosis in the medullary form is very unfavorable. The disease generally proves fatal in a few months. When the tumor breaks down and sloughs, a friendly hemorrhage sometimes relieves the patient from his misery. Metastases are frequent, and in Cahn's case of carcinoma of the submaxillary gland they involved the bones exclusively. In the scirrhus form the prognosis is better; but it can hardly be said that, up to the present time, anything like satisfactory results have been obtained in carcinoma of the salivary glands.

When the disease is secondary to carcinoma of the oral cavity or jaws, the differential diagnosis would consist in determining whether the salivary glands or the lymph nodes were the parts involved and whether the disease was located upon or within their sheaths; and, without an examination of thin sections under the microscope, it would probably be impossible in most cases to determine what were the facts. In the case of a tumor which had been growing slowly through a period of several years suspicions would naturally be aroused by the onset of rapid growth and the involvement of lymph nodes; but here, again, a definite diagnosis could hardly be made without the aid of the microscope. When the tumor develops primarily in the parotid or submaxillary gland, the age of the patient, the progressive increase in size. the enlargement of the lymph nodes, the presence of pain due to pressure upon nerves, and the cachexia are the main symptoms upon which one must base an opinion. The encephaloid form may bear a very close resemblance to an inflammatory enlargement, particularly the chronic inflammatory tumor of Kuettner. The differentiation of other conditions has already been referred to in speaking of the diagnosis of mixed tumors.

Cysts of the Salivary Glands.—Occasionally cystic collections have been observed in the salivary glands and in their efferent ducts. Those involving the sublingual gland and its ducts are commonly known as "ranulæ." These, with cystic degeneration of the Blondin-Nuhn glands, have been described in a previous section. (Page 259.) It remains only to speak of cysts in connection with the parotid and submaxillary glands. The occurrence of cystic dilatation of Wharton's and Stenson's ducts, without complete occlusion of their orifices—which latter condition is proven by the fact that a few drops escape from the duct when a stimulus is applied to the mucous membrane of the mouth—is difficult to explain. More commonly, the dilatation is due to the presence of a calculus or to a cicatricial narrowing of the natural opening of the duct. The shape of such a dilatation is generally oval and elongated, and the swelling lies in the natural course of the duct. If a probe can be made to enter the orifice, repeated probing should bring about a cure; but, if this fails, a fistula opening into the mouth should be established. This may be done by passing a needle threaded with silk into the cyst and out again at some distance from the point of entrance. The silk is then tied tightly. Necrosis and separation of the included tissue will leave an opening into the mouth, and this opening often remains permanently. A simple incision or the employment of McGraw's elastic ligature will often accomplish the same object. If the cyst is accessible, and if there is considerable dilatation, a portion of the cyst may be excised and the border of the sac stitched to the mucous membrane all round. This should be followed by a permanent cure. Cysts in the glands result from the closure of some of the smaller duct branches, such closure being the result of an inflammatory action or of cicatricial contraction. Occasionally two or more cystic dilatations run together and form a cyst of some size; and in some instances, as the result of proliferation of connective tissue, the wall of the cyst may become quite thick. Certain portions of the glands seem to be destroyed by the cysts, and, if the latter attain any considerable size, they may cause pressure atrophy of the surrounding gland tissue. Koenig saw a cyst, the size of a hen's egg, that grew in the anterior part of the parotid; its contents were of an atheromatous nature. Tuberculous and echinococcus cysts have been observed in the parotid.

When the cyst is small, the diagnosis is difficult or impossible; when it is of appreciable size, fluctuation may be obtained. When the cyst projects well forward and the overlying skin has undergone pressure atrophy, the contents of the cyst may be seen to be transparent. It is sometimes difficult to differentiate between a simple cyst and one associated with a new-growth. The use of an exploring-needle and the examination of the cyst contents may be required to confirm the diagnosis.

Koenig has obtained good results, in a certain percentage of cases, by the injection of iodine. Liquid zinc chloride and solutions of carbolic acid have been used for the same purpose. In the case of the parotid, the injection should be tried before more difficult operative measures are decided upon. Simple incision would be followed by a persistent sinus or fistula, and there would always be danger of infection. When the cyst wall is thickened, it may be enucleated. This should be done as quickly as possible by blunt dissection, as the hemorrhage is often profuse. If, in the case of the submaxillary gland, the treatment by injections should fail, extirpation of the whole gland would give the best result. The operation does not seem to be followed by any appreciable disability.

Extirpation of the Parotid.—The removal of a carcinoma of the parotid is always a serious and bloody operation, and is justified only in favorable cases. Sometimes a portion of the gland containing the facial nerve may have to be left. If the horizontal incision is not carried above the level of a line drawn horizontally three-quarters of an inch below the lobule of the ear, the trunk of the facial nerve will not be seriously injured. Occasionally, these partial operations are followed by very favorable results, the patient remaining free from recurrence for years afterward. If the growth is limited to the parotid, and if the overlying tissue is little, or not at all, involved, as shown by its being easily movable on the underlying tissues, the operation may be undertaken; but in cases where the tumor is soft and has been of rapid growth, the chances of early recurrence are as great as after removal of a similar growth in the breast. If the growth is absolutely fixed on the underlying tissues and quite immovable, one may infer that adhesions to the deep vessels have already formed and that consequently the tumor is practically irremovable. One of the first essentials, in an operation of this kind, is good access to the seat of the disease. A long vertical incision, extending from the lobule of the ear to well below the angle of the jaw, should be made over the growth. A transverse incision should then be carried from the centre of the first incision across the cheek. If any of the overlying tissue is found to be adherent to the tumor, it should be removed by an elliptical incision. The operator will do well to keep outside the growth, and to work strictly in healthy tissue. This is necessary to insure a complete removal of the carcinoma and to avoid the continuous oozing of blood and broken-down tissue from the wound, which would otherwise occur. The ligature of the internal carotid artery, which has been recommended by some, is an operation not without danger. It is of doubtful utility as a preventive measure, and is to be recommended only in exceptional cases. At this stage the surgeon should not be bound by any hard-and-fast rule of procedure. It is sometimes easier to work from above, and sometimes from below. The separation of the anterior portion of the tumor from the masseter is accomplished without difficulty. Sometimes the posterior border may be readily freed from the sterno-mastoid. Faure recommends the removal of a layer of this muscle, so as to avoid opening the capsule. The lower border can then be gradually turned up. The last attachments to be divided will be the fascia that goes to the pharynx and to the styloid process, and the superficial temporal and internal maxillary arteries. Besides the terminal divisions of the external carotid, the following vessels will have been divided: the transverse facial, the occipital and the posterior auricular arteries, the external jugular vein, and the large connecting branches between it and the internal jugular vein. To facilitate the removal of that portion of the parotid which lies in the retro-mandibular space, Faure recommends the excision of a portion of the vertical ramus of the jaw, about 1 cm. broad and extending from the base of the condylar process to the near angle of the jaw. A regional dissection of the lymph nodes should be done at the same time.

Removal of the submaxillary gland is comparatively simple. A curved incision is made along the lower border of the tumor. The overlying tissues (including the platysma) are quickly divided, the cervical fascia is opened, the lower border of the gland is turned up, and the facial artery is ligatured at a suitable distance from the external carotid. By blunt dissection the gland is removed from the underlying tissue and submaxillary fossa, and turned up upon the cheek; after which the facial artery and vein will be again divided, and a ligature placed around Wharton's duct. Because of extension of the disease by infiltration, it may be necessary to divide the hypoglossal nerve and the lingual artery, and to remove the hyo-glossus muscle. If the floor of the mouth is involved, the lingual nerve may be divided at the same time.

Anomalies of the Salivary Glands.—Congenital absence of the salivary glands has been reported, although it is extremely rare. In Turner's case, both submaxillary glands were situated on the upper surface of the mylo-hyoid muscle.

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SURGICAL DISEASES AND WOUNDS OF THE NECK.

By JOHN M. ELDER, M.D., Montreal, Canada.

I. CONGENITAL MALFORMATIONS.

Congenital malformations are not so rare as was at one time supposed, but are of interest to the surgeon only in so far as they give rise to conditions or complications which may demand treatment at his hands.

Etiology.—Rational treatment of these conditions presupposes a correct conception of their origin, and for this we must look to embryology. We find here that these malformations are very frequently connected with the development of the cervical, branchial clefts, and are thus analogous to hare lip, or cleft palate, higher up. Failure in the development of these clefts will give us two main classes of malformations: (1) fistulæ, and (2) cysts;—and the branchial fistulæ again are capable of further subdivision, according as they are external or internal, median or lateral. Other congenital deformities which may give rise to symptoms demanding surgical interference are: cervical ribs, lymphangiomata of the neck—the so-called cystic hygromata,—and dermoid cysts.

1. **Congenital Fistulæ of the Neck.**—These fistulæ, looked at embryologically, are either (a) branchial, the remains of the branchial clefts, or (b) the persistence of some part of the thyro-glossal duct. The branchial fistulæ are usually lateral, whereas the thyro-glossal fistula is always a median one. Branchial fistulæ may be complete or incomplete, and the incomplete fistulæ may either open externally on the skin at the side of the neck, or may present themselves only internally as pharyngeal or œsophageal diverticula. The complete fistula, of course, forms a canal from the skin of the neck to the pharynx or œsophagus. The position of the external opening will depend upon the cleft from which it has arisen. The external orifice, which is often cartilaginous, bears no relation to the inner end of the tube, which nearly always opens in the region of the tonsils, and therefore corresponds to the second branchial cleft. A common site for the external opening is at the posterior margin of the sterno-mastoid muscle, just above the clavicle, though again it may open higher up, close to the angle of the jaw.

The fistula is a narrow, well-defined, usually tortuous canal, and frequently passes between the external and internal carotid arteries to reach the pharynx, where it either ends as a cul-de-sac or opens directly into some part of the food tube. In the former case the epithelium lining the canal secretes only a small quantity of mucus, and so the fistula may long pass unnoticed and give little or no trouble until it becomes accidentally infected from without: but, should it open into the pharynx or upper part of the œsophagus, it may become very troublesome by transmitting particles of food, and still more so by the inflammation caused by the passage or retention of these particles.

The blind internal fistulæ (pharyngeal or œsophageal diverticula) will be noticed under diseases of those parts.

Treatment.—While the great majority of these branchial fistulæ produce few or no symptoms and therefore do not require treatment, there is always a chance that such a fistula, especially if complete, may become inflamed or infected, and give rise to such serious discomfort or deformity as to require relief. The only rational treatment is complete dissection of the fistulous tract, and when one realizes the anatomical relations it will be readily granted that this is no easy matter to do. A cotton-tipped probe, dipped in a strong solution of nitrate of silver, should first be passed into the fistula and an effort made to destroy all the lining epithelium; for, if any of it remain, it will mean recurrence of the trouble. The probe acts at the same time as a guide to the dissector. Further, if the fistula be complete, it will be found a difficult matter to suture securely the inner opening, so that no pharyngeal fistula may persist along the track of the wound. After such suturing, the wound should be carefully closed, but a gauze or cigarette drain, extending down to the pharynx, should be left in place for forty-eight hours, in case of leakage or infection. If a complete fistula has been thus dissected out, rectal feeding only should be employed for several days, and only boiled water given for cleansing the mouth and to assuage thirst.

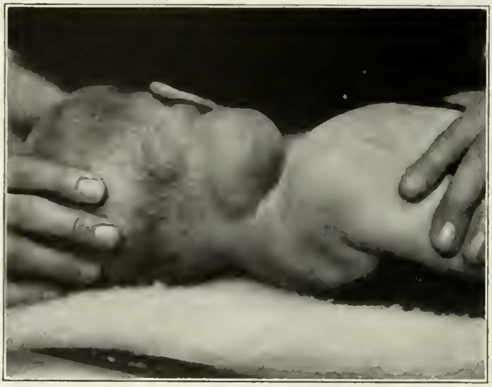

Fig. 237.—Branchial Cyst ("Branchial Dermoid"). From a photograph of a child at the author's clinic in the Montreal General Hospital. A good result was obtained by dissecting out the growth.

One has only to consider the anatomical course of these fistulæ to realize the disfiguring nature of the scar which must remain after such an operation, even when successful. Add to this the probability of failure, and one can readily understand why even good surgeons speak very guardedly about the radical cure of these fistulæ. But one thing does seem certain, viz., that it is worse than useless to attempt less heroic treatment, and most surgeons will condemn attempts at cure by cautery, injection, caustics, or scraping. The only result likely to be obtained by such a course will be to convert the fistula into a cyst or diverticulum, by closing the external orifice.

Fistulæ of the thyro-glossal duct (median fistulæ) will be considered farther on, in the article on "Diseases of the Thyroid Gland."

2. **Branchial Cysts.**—The relation of these to branchial fistulæ is easily understood. In the development of the branchial clefts, it may happen that both ends of the cleft close, while in the intermediate portion there is a failure of the walls to coalesce, thus forming a cyst. This unobliterated portion of the cleft may remain unnoticed for several years, and then may appear as a slowly growing, painless cyst, which may give trouble if it becomes infected, or may produce pressure upon neighboring structures by its increase in size.

Removal of this cystic tumor may also be desired for cosmetic reasons. If the cyst be at the outer end of the branchial cleft it will be lined with squamous epithelium and will, as it develops, present the characteristics of involution cysts in general and will therefore approach the dermoid type —the so-called *branchial dermoid.* (Fig. 237.) On the other hand, if it be the inner end of the tube which has become cystic, lined as it is with cylindrical epithelium, it will be gradually distended with a thin mucous secretion—a condition which is commonly known as *hydrocele of the neck.* (Fig. 238.)

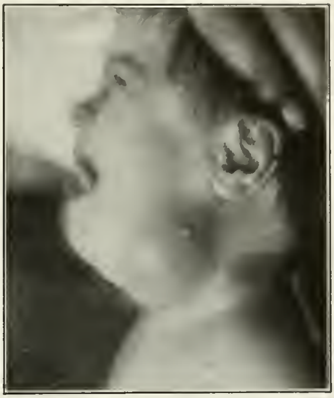
Fig. 238.—Branchial Cyst ("Hydrocele of the Neck"). From a photograph of a child at the author's clinic, Montreal General Hospital. The child made a good recovery after dissection of the submaxillary triangle.

These branchiogenic cysts are usually found in the upper part of the neck, between the hyoid bone and the mastoid process, and are often mistaken for tuberculous lymph nodes. Hydrocele of the neck is usually developed much more rapidly than the branchial dermoid and, as it may push up the floor of the mouth, has often been mistaken for ranula; but the history of its growth—from birth onward—usually clears up the diagnosis. It is said that these branchial cysts are peculiarly prone to malignant changes, and, reasoning from analogy, one can readily believe that this is true. Primary carcinoma of the neck has probably always some such origin.

Dermoid Cysts.—Dermoid cysts are not common in the neck. They are easily confounded with lipomata, but the mistake does not seriously concern the patient, as the treatment for both conditions is the same, viz., excision—an operation which presents no special difficulty.

The branchial dermoid cyst is usually filled with sebaceous material, hairs, and other cutaneous structures, more or less altered in character; and, though present at birth, it often remains unnoticed until adult life, when it may, owing to accidental infection, suddenly increase in size and give symptoms of inflammation. It usually presents itself in the upper part of the anterior triangle of the neck, tends to swell directly forward, and does not push up the floor of the mouth, as the serous cysts do. Its slow development, its superficial situation, and its liability to infection and suppuration will generally distinguish it from the serous cyst. If any doubt exists, puncture of the sac and examination of the contents will determine the nature of the tumor.

Sometimes the contents of these branchiogenic cysts are of such a mixed character that one is justified in classing the cysts themselves as partly dermoid and partly mucoid. The presence of squamous epithelium in one part of the lining of the sac and of cylindrical epithelium in another would easily explain the mixed character of the contents.

Congenital Serous Cysts.—Just as we may have a too free local anastomosis between the more superficial blood-vessels, giving us the different degrees of angiomata, so we may have an analogous congenital condition in the lymphatic vessels, giving rise to the so-called lymphangiomata. If these lymphatics coalesce, as a result of the extra pressure thrown upon their walls, we get the cystic lymphangioma, or serous cyst, which is usually multiple, contains normally a clear coagulable fluid, and tends to grow slowly and to displace the neighboring structures. Any sudden increase in the size of the growth means hemorrhage into the cyst, an occurrence which not infrequently takes place. These serous cysts may develop either from the superficial or from the deep lymphatics, and may occupy any position, although the favorite site is at the upper part of the neck, where their continuous growth forms a sort of collar around the neck, even extending to the back.

Diagnosis.—The diagnosis is ordinarily not very difficult. The characters which generally distinguish these growths from others in this region are the following:—A small fluctuating tumor, present at birth and occupying a different position from that of a branchial cleft; slow-growing, not including the neighboring structures (cf. Sarcoma), and not compressible (cf. Cavernous angioma). The use of the aspirating needle would also help in a doubtful case.

Prognosis.—As is true of other congenital tumors in this region, the prognosis is not very favorable. Unless surgical interference is resorted to, the tumor is almost certain to continue growing, and so, by pressure, to cause trouble.

Treatment.—The treatment which promises the best results is complete excision. This operation, however, owing to the fact that these tumors have no definite wall or sac, is a difficult one, and often necessitates an extensive dissection. Further, as the thin walls of the lymphatic vessel collapse when the fluid escapes, it is very difficult to be sure that all diseased tissue is removed. According to my experience the best method of overcoming this difficulty, at least in a measure, is to inject the cyst, through an aspirating needle, with a weak solution of methylene blue, and then afterward to remove the tissues so stained. It is often a source of surprise, in a case of apparently superficial serous cyst of the neck, to what a great depth one must carry the dissection.

Multilocular Branchiogenic Cysts.—In addition to these two main classes of branchial cysts we often have in the neck another congenital cystic condition, viz., the multilocular branchiogenic cysts. These cysts, which belong to the serous type of cysts, are present at birth, usually increase gradually in size, and may appear in different situations in the anterior triangles. They are usually multiple as well as multilocular, and many authorities regard them as identical with the cystic lymphangiomata, and therefore not true branchiogenic cysts at all. In an exhaustive article on the subject in the *Revue de Chirurgie* for September, 1908, MM. Estor and Massabau, of Montpellier, France, discuss these cysts and cite many cases. They arrive at the conclusion that these tumors are complex in origin and character, that they are distinct from the polycystic parathyroid tumors of P. Berger, and that they approach the cystic lymphangiomata in type rather than any other known form of tumor. These authors do not think that these cysts are analogous to the cystic neoplasms which sometimes (rarely) develop from the embryonic "rests" that occasionally persist along the course of the branchial clefts.

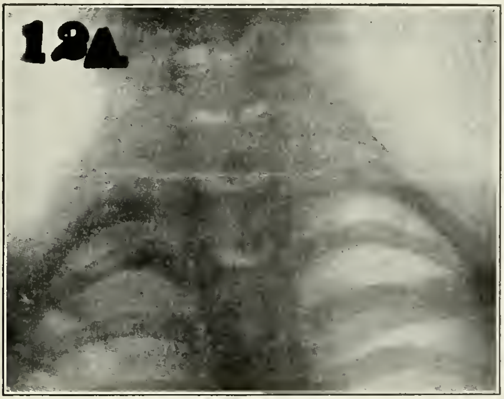

FIG. 239.—Skiagram of Cervical Ribs. (By permission of Dr. C. K. Russel, Montreal.)

TREATMENT.—The treatment of these cysts—when treatment is required—differs in no way from that indicated in the case of other congenital anomalies, viz., careful removal by open dissection.

Complete excision is the only remedy; for any failure to remove *all* the lining epithelium of the cyst will be followed eventually by a recurrence of the tumor, and the cicatricial tissue developed by the first removal will render any subsequent operation a difficult matter. Excision of these cysts is at all times difficult, owing to the facts that the walls are thin, and further, that they are always intimately connected with the carotid sheath, if situated low down, and with the submaxillary glands, or the tonsil, if situated higher up.

These true branchial cysts, especially the hydrocele of the neck, are often difficult to distinguish from the cystic hygroma.

3. **Cervical Ribs.**—This congenital deformity is not so uncommon as was at one time supposed, when anatomists, not neurologists or surgeons, reported most of the cases. The Roentgen skiagrams have added much to our knowledge on the subject, and many cases which were formerly regarded as cases of neuritis of the upper extremities have by this means been shown to be due to pressure upon the brachial plexus caused by a cervical rib, and have been relieved by surgical intervention.

Anatomically, these ribs are analogous to the supernumerary floating lumbar ribs below, and are really hypertrophies of the transverse processes of the lower cervical vertebræ. They are either complete (joining the sternum) or incomplete, and in the latter case the rib may simply project forward as an elongated transverse process (Fig. 239) or bend down to coalesce with the first thoracic rib near the scalene tubercle. (Fig. 240.) Skiagrams show us that the deformity is usually bilateral and symmetrical; and statistics would indicate that it occurs much oftener in females than in males. This may be due to the fact that deformity of the female neck would be much more apt to be noticed than a similar condition in the male.

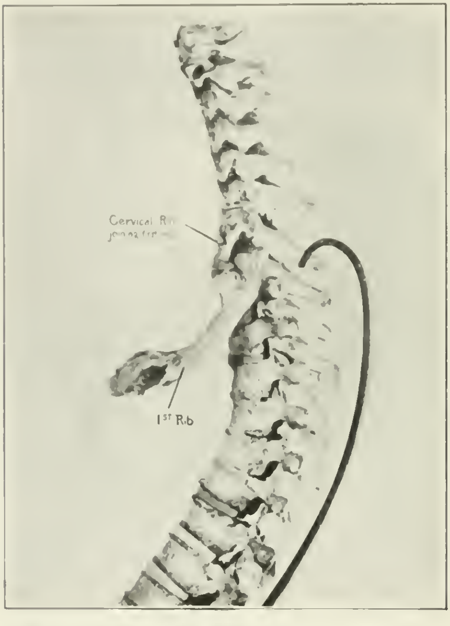

Fig. 240. Cervical Rib. (From a specimen in the Anatomical Museum, McGill University, Montreal.) Note deformed first rib.

The relation of the cervical rib to the vessels and nerves passing down to the upper extremity is of the very greatest importance, as it is this fact which largely determines whether or not symptoms will develop. If the cervical rib be complete, or if it join the first rib at the scalene tubercle, the scalenus anticus muscle will be attached to it, instead of to the first thoracic rib, and the subclavian artery will hook over the cervical rib, thus forming a rather acute angle as it suddenly dips down toward the axilla. (Fig. 241.) The vein will, of course, be separated from the artery by the muscle, and thus, lying lower down, it will escape pressure. The roots of the brachial plexus of nerves will also pass over the rib just above the artery, and they too will be angulated over the rib, and may be stretched sufficiently to produce a neuritis which is referred to the peripheral nerve endings. If the ribs be incomplete (Fig. 239) the blunt anterior extremities, as they grow forward into the neck, may press upon these same structures. Most of the reported cases belong to this latter class, but, as they are the most numerous, that is to be expected.

Symptoms.—Symptoms are often entirely absent, and only the presence of a hard tumor in the neck, frequently discovered by accident, leads to a skiagram being taken and to the discovery of the real nature of the defect. Although the anomaly is undoubtedly congenital, symptoms do not as a rule show themselves until early adult life (sixteen to thirty), and often they are induced, even in people of middle age, by a change of occupation rendering necessary some unusual employment of the hands or arms. I know of one case where the deformity became known only late in life, and was then made evident only by the presence of a hard tumor in the neck, which had become prominent as a result of wasting of the muscles in a patient suffering from carcinoma of the liver. Apart from the presence of a tumor in the neck, the symptoms will, of course, depend upon the structures interfered with on their way down to the arm. From its anatomical position the vein is rarely interfered with, and thus œdema of the arm is very rare in these cases. This leaves us the artery and nerves to be considered, and, as both W. W. Keen (*American Journal of Medical Sciences*, February, 1907) and C. K. Russel (*Medical Record*, February 16th, 1907, and *Montreal Medical Journal*, March, 1907) have shown, these structures do give two definite sets of symptoms.

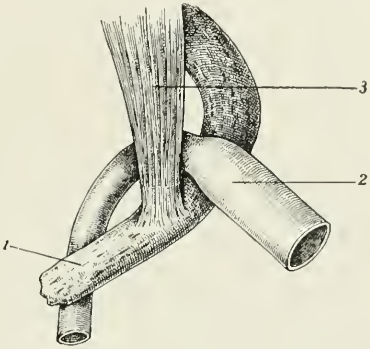

Fig. 241.—Rudimentary Rib. (Case of Dr. W. W. Keen.) 1, Cervical rib; 2, subclavian artery; 3, scalenus anticus muscle. Note the marked increase in size of the subclavian artery after escaping from behind the scalenus anticus.

(a) *Nerve Symptoms.*—Russel has demonstrated (*loc. cit.*) that sensory disturbances in the upper extremity correspond, in the main, to the distribution of the lower cords of the brachial plexus (eighth cervical and first dorsal roots): and this is what one would expect in these cases, because these roots are (owing to their origin) more sharply hooked over the cervical ribs in the neck. As a result of this pressure neuritis, the muscles supplied by these roots will be liable to atrophy, and in the intrinsic muscles of the thumb and little fingers (thenar and hypothenar group) we do find atrophy. Keen's observations (*loc. cit.*) are to the same effect. Pain in the arm, of a neuralgic character and rendered worse by exertion, especially if confined to one arm, should lead to a suspicion of this trouble, and a skiagram should always be taken, as palpation cannot be relied upon to demonstrate the presence or absence of a cervical rib.

(b) *Circulatory Symptoms.*—All writers and observers are pretty well agreed that in these cases the subclavian artery rises much higher in the neck than normal, and Keen and Russel (*loc. cit.*) have shown that there is a definite narrowing of the lumen of the artery as it winds over the supernumerary rib. (Fig. 211.) In some cases, the pressure exerted upon the subclavian artery by the outgrowing incomplete rib may actually obliterate the vessel and thus interfere so seriously with the nutrition of the hand and fingers that they become cold and blue and may finally show such definite nutritive changes as to simulate Raynaud's disease. In rare cases gangrene of the finger tips may result. A short time ago Dr. E. W. Archibald showed such a case before the Montreal Medico-Chirurgical Society, and the circulatory disturbances and nutritive changes in the arm were so great that the case was considered to be one of sclerosing endarteritis. A skiagram subsequently showed the true condition, viz., a cervical rib pressing upon the nerve trunks. Operation was advised, but the patient refused. Death occurred later from another cause, and it was then found, at the autopsy, that the artery was constricted as it passed over the cervical rib. The writer remembers a case where the subclavian artery, at the point in the neck where it passed over a cervical rib, showed increased pulsation and in addition there was a markedly weak pulse at the wrist in the same arm. These conditions suggested aneurysm, and such a diagnosis was actually made, but no operation was undertaken.

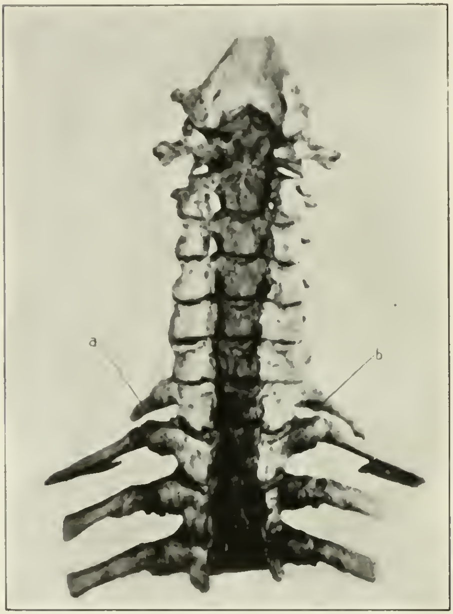

Fig. 212.—Rudimentary First Thoracic Ribs (*a*, *b*), Incomplete, Simulating Cervical Ribs. (Anatomical Museum, McGill University.)

But it must be remembered that cervical ribs will not always be found where even all the above symptoms are present. There appears to be no connection between Raynaud's disease and cervical ribs, and yet the two are often symptomatically identical. Further, in a number of cases which I have seen, symptoms identical with those which I have just been describing were present, and yet there was found in each instance a rudimentary or deformed first thoracic rib,—not a cervical rib. (Figs. 242 and 243.) Keen (*loc. cit.*) also cites such cases. A skiagram will show that here we have no trace of cervical rib, and yet in two cases which I have seen operated upon as cervical ribs, and in which a portion of such deformed first thoracic rib, posterior to the scalene tubercle, was resected, recovery from all symptoms followed. It is quite conceivable, and probably often happens, that exostoses of these deformed ribs (and they are very liable to such outgrowths) would give symptoms identical with those of a cervical rib. One should never promise, therefore, that operation will relieve all the symptoms. There are too many factors which enter into this symptom complex to render such a prognosis a safe one.

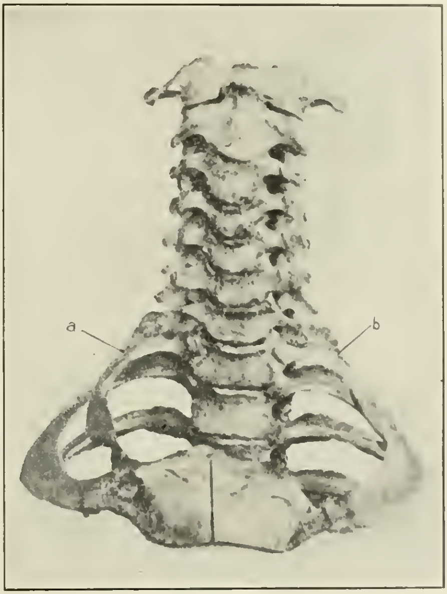

FIG. 243.—Deformed or Rudimentary First Thoracic Ribs (*a*, *b*), Complete. (Anatomical Museum, McGill University.)

TREATMENT. — Should definite symptoms (not cosmetic results) render surgical interference necessary, the only profitable procedure is a resection of that portion of the rib which is producing pressure. This must be done carefully owing to the proximity of the dome of the pleura, and to the fact that it is probably attached to the periosteum of the rib. (Fig. 244.) The periosteum must always be removed with the rib, as otherwise there will be regeneration of bone, often a bony exostosis, which would be worse than the original rib.

Operation.—A curved incision, beginning a little below the middle of the posterior border of the sterno-mastoid muscle (vide Fig. 31, page 125, Vol. IV., Watson-Cheyne and Burghard's "Surgery") and extending transversely back to the anterior border of the trapezius muscle, thence down and again forward along the clavicle to the sterno-mastoid, will mark out the skin flap to be raised and reflected forward. The deep fascia is next opened, and the external jugular vein should preferably be now ligated. If the sterno-mastoid muscle be next pulled firmly inward with a blunt retractor, and if the posterier belly of the omo-hyoid muscle be defined and pulled up on a Kocher's retractor or blunt hook, the subclavian vessels and the cords of the brachial plexus will be seen coursing outward over, or in front of, the cervical rib. Usually one can now get between the vessels and nerves, and, by pulling the latter gently up and the former down, can in this way expose the rib lying upon the pleura. In doing this, the operator must be careful not to produce undue traction on either vessels or nerves (especially the latter). The periosteum covering the rib should next be incised freely, as in the ordinary operation for excision of a rib, and the portion of rib which it is desired to remove should be cut with the costatome or a pair of pointed bone pliers, and then lifted out of its periosteal sheath, which can be removed later. One must be very careful to trim the cut ends of the rib, so that they may not subsequently damage the vessels or nerves, which, when released, will fall down into the space made by excision of the bone.

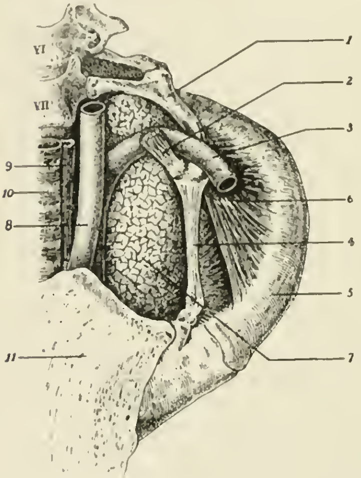

Fig. 244. Rudimentary Rib in its Relations to Surrounding Parts. (From Luschka.) 1, Rudimentary rib with its knobbed end, to which is attached the scalenus anticus. 2. 3, subclavian artery; 4, ligamentous cord, by which the rib is prolonged to the sternum. 5, first dorsal rib. 6, intercostal muscle between the cervical rib and the first dorsal rib; 7, the lung; 8, left carotid artery; 9, œsophagus, 10, trachea; 11, sternum. Note the relation of the pleura and lung to the cervical rib.

The next step—viz., the dissection of the periosteum from the underlying and often attached pleura—is the most difficult one. Before this is attempted, all oozing should be stopped, and it is a good plan to allow the patient to come fairly well out of the anaesthetic, as, in case the pleura should be opened and the lung suddenly collapse, there often supervene an alarming cyanosis and temporary respiratory failure. These symptoms, as a rule, soon yield to stimulants. Should the pleura be punctured in dissecting off the periosteum, the opening should be at once sutured. No permanent symptoms follow this casual opening of the pleura. The operation is completed by closing the wound in the usual way.

Some operators make an incision just above the clavicle, as for ligation of the subclavian artery, and a second incision at right angles to this up the neck.

Torticollis.—This condition, which is held by some authorities to be congenital, is treated elsewhere in this work (Vol. IV., p. 767).

II. INJURIES OF THE NECK.

Injuries of the neck may be classified as accidental, homicidal, or suicidal, and the chief interest centres in the structures injured. Owing to the exposed situation of the neck and the size and importance of the vessels and nerves in this region, injuries give two main classes of symptoms with which the surgeon has to deal, viz., hemorrhage (arterial or venous), and paralysis, the result of injury to one or more of the nerve trunks.

Injuries of Arteries in the Neck.—SYMPTOMS.—Hemorrhage is, of course, most important, but is not always at once visible, as the blood may escape into the œsophagus, or it may be masked by forming a hæmatoma in the tissues. The large arteries are usually injured by stab or gunshot wounds, more rarely as a result of suicidal cut-throat. This is doubtless due to the fact that the suicide, from his lack of anatomical knowledge and his over-anxiety to attain his object, throws the head well back before cutting the throat, thus rendering prominent the thyroid cartilage and tracheal structures in the centre and the sterno-mastoid muscles at the sides, and even the ramus of the jaw, all of which protect from the knife, or other instrument used, the vessels which have fallen into the hollow between the trachea and muscles at either side of it. (See "Cut-throat," *infra.*)

The amount of hemorrhage in any given case will depend upon the size of the vessel wounded and upon the freedom with which the blood can escape from it. Should a large artery be severed, a fatal hemorrhage would speedily ensue; but it does sometimes happen—notably in punctured wounds—that a large vessel is wounded, but not completely severed; and here the hemorrhage may occur so slowly that either it is overlooked or else the symptoms are so masked that collapse of the patient alone reveals the extent of the injury. One cannot compress the neck firmly without interfering with respiration, and yet the oozing may take place so gradually that one often hesitates for too long a time before deciding to open the wound and ligate the bleeding point. In small vessels the bleeding may cease spontaneously with the lowered pressure induced by hemorrhage and shock, but it will generally recur again as soon as the heart recovers its tone; and these are the very cases which require careful watching, and often very prompt treatment, to prevent regrettable results.

True secondary hemorrhage is always to be dreaded in punctured wounds of the neck, and is most liable to occur about the fifth day. Unless boldly treated by open incision and ligation of the wounded vessel, it may recur again and again until a fatal result ensues. Two main factors appear to determine this secondary hemorrhage: (1) The liquefaction of a hæmatoma which may have temporarily plugged the wounded vessel; and (2) erosion of the vessel walls. The latter event occurs either as a result of damage to the walls (without actual perforation) at the time of the accident, or as a result of subsequent suppuration.

The experience of military surgeons, in recent wars, with the present high-velocity bullet, has made them particularly alive to this danger of secondary hemorrhage in bullet wounds of this region; though the more common danger is doubtless that of the formation of an aneurysm at a later date.

Diagnosis.—The most important question to be decided is whether the hemorrhage is arterial or venous,—not an easy matter, if the case be not seen until a certain length of time has elapsed. As a rule, the dark color of venous blood and its steady flow, as contrasted with the bright red of arterial blood and its pulsating flow, will enable one to decide the question. But it does happen, especially if a hæmatoma forms an obstruction or if the patient has lost much blood, that the bleeding from an artery may simulate that from a vein. If the patient's condition permits, it is always advisable to determine definitely the bleeding point by enlarging the wound, and then to apply a ligature. This will obviously be more difficult in the upper and lower triangles than in the mid-triangles. As regards the diagnosis, not much reliance is to be placed upon the symptom mentioned by Wahl, who states that a stethoscope applied over the wound of the vessel will reveal a soft, blowing murmur synchronous with the heart-beat if the vessel be only partially divided, but an entire absence of murmur if it be completely divided. I remember an instance where a vessel (the brachial artery) was completely severed, and yet Wahl's sign was present, and was successfully utilized by the late Dr. Fenwick of Montreal to locate the exact site of the injury.

In our efforts to determine which one of the two main arterial trunks (carotid or subclavian) is causing the hemorrhage, we should naturally look for absence or weakness of the pulse in their distal branches; but it should always be remembered that this symptom will speedily disappear, so free are the arterial anastomoses in this region.

Prognosis.—The prognosis will obviously depend upon many considerations, such as length of time since the injury; the amount of blood lost; the site of the injury; the likelihood of sepsis; and the other structures injured (*e.g.*, nerve trunks, air passages, etc.). In a suicidal case the patient's mental condition is also a very important factor.

General Treatment.—This should, above all things, be prompt and thorough. The surgeon should never be satisfied until all bleeding points have been ligated, even though such a procedure may mean an extensive and difficult dissection upon a patient already in a condition of considerable shock. In some cases an antiseptic compress should be temporarily applied and the more radical operation undertaken only when the patient has sufficiently recovered from the shock of the original wound. But during this intervening time the patient should be most carefully watched, owing to the possibility of concealed hemorrhage. Not infrequently it may be found necessary to undertake the ligation (temporary or permanent) of the injured vessel at some point proximal or distal to the site of injury, as the tissues here may be so infected or injured that it would be either impossible or unsafe to secure the vessel. But when this ligature has been applied, one should always enlarge the original wound and secure both ends of the damaged vessel, as owing to the free anastomosis here it will not be sufficient to secure one only. At the same time the exposure of the parts would afford an opportunity of noting the amount of damage done to other structures, and of repairing such damage by suture, so far as that might be possible.

For the technique of ligation of any vessel in the neck the reader is referred to the section on Aneurysm in this article and to the article on "Ligature of Arteries and Veins," Vol. IV., p. 468 *et seq.*

Injuries of Veins in the Neck.—In addition to the more remote risks of sepsis and thrombosis there are two immediate dangers always to be apprehended in these injuries; viz., hemorrhage and air embolism.

1. *Hemorrhage.*—Owing to the absence of valves in the veins of the neck, and also to the fact that the cervical fascia often holds these vessels in such a way that the severed ends must remain open, venous hemorrhage from the large veins is perhaps more speedily fatal here than is arterial. The respiratory act, by producing a negative intrathoracic pressure, also assists in causing profuse bleeding from a comparatively small vein in the neck. The hemorrhage may be, as in the case of the arteries, either frank or concealed, and secondary hemorrhage is as much to be dreaded from wounded veins as it is in the case of wounds of arteries.

2. *Entrance of Air into the Veins.*—Owing to the large size of these cervical vessels, and to the fact already mentioned that the mouths of the several vessels are held open by the attachments of the fascia, one can easily understand how a bubble of air might enter such a wound, especially during the inspiratory act. The hissing sound which quickly follows the wounding of a large vein, particularly at the root of the neck, is especially dreaded by all operating surgeons, alive as they are to the danger of "air embolism." That a large bubble of air, getting into the venous circulation, may produce fatal effects, there seems no reason to doubt; but that it always does so is certainly not true. The frequency of the accident, and the rarity of this effect, need only be mentioned to establish this point. (See the paragraph on "Cut-throat," *infra.*) The symptoms are those of syncope, with embarrassed respiration; and these same symptoms are so frequently associated with other conditions (operative or otherwise) in this region, conditions in which air embolism could not occur, that it is doubtful just how far they may be attributed to air embolism in any given case. Still, it is one of the dangers that must be reckoned with in wounds of the cervical veins, and the operator should always be most careful to prevent it, so far as is possible.

Treves advises flooding the field of operation with normal saline solution where the danger is apprehended, and, should the air have got in, he very ingeniously advises strong compression of the thorax in the expiratory act, the finger at the same time being taken off the wounded vein. By this means one might hope to expel the air, and Treves claims to have saved patients by this procedure.

Should a large vein be accidentally wounded during the progress of an operation, the opening should be at once stopped with the finger, which should be kept there until the vessel is compressed above and below and subsequently sutured or ligated.

TREATMENT.—The one effective treatment for injury to a cervical vein is to close the opening in a permanent manner. This may be done in various ways. If the vein be small, ligation is best, because quickest and surest. But if the vein be large, one would prefer to close the wound and yet preserve the function of the vessel. This may be done by the lateral ligature, if the tear in the vessel wall be small, or by suture if the wound be a large one. Silk is perhaps the best ligature material, and the size selected should be the smallest that will answer the purpose; whereas for suturing a wound of a vein, catgut, or some absorbable material, is preferable, though some surgeons prefer silk here also.

These sutured veins functionate perfectly well afterward, and are seldom, in these days of aseptic and antiseptic surgery, thrombosed. The old dangers of phlebitis and pyæmia, which were so much dreaded in the pre-Listerian period of surgery, are not now an important factor. When it is thought best to occlude a wounded vein by ligation it should always be by double ligation, the vessel being subsequently severed between the ligatures. Continued pressure by clamps, or otherwise, is to be condemned, as it predisposes to the danger of secondary hemorrhage.

Cut-Throat.—This particular form of injury to the neck is so commonly met with in general practice, that it demands special mention in a practical treatise upon the surgery of the neck. The injury is generally inflicted with suicidal, though sometimes with homicidal, intent. It is a favorite method of self-destruction with the insane, especially those who are suffering from melancholia.

As we have previously mentioned, the injury, though a horrible-looking wound, is rarely primarily fatal, and we have suggested the reason for this.

Character of the Wound in Cut-throat.—In this injury all degrees of severity are met with, from a harmless and easily treated skin wound to a fatal severance of all the soft structures lying in front of the vertebral column. Roughly, we divide cut-throat into two classes, namely: those in which the air passages have not been opened, where the risk is chiefly from hemorrhage; and secondly, those in which the air passages have been opened, where the risk of subsequent bronchopneumonia, as well as that of hemorrhage, must be faced.

If done with suicidal intent the cut is usually made directly across the throat, and the centre of the wound will fairly correspond to the median line. If the cut is made with homicidal purpose, it is very likely to be more on one side than on the other, owing to the struggles of the victim. This rule, however, would not hold if the victims were asleep when attacked, as has happened frequently in the case of an insane parent murdering his or her children in this way.

By far the most common site for these wounds is just above the prominence of the thyroid cartilage, and the cutting instrument appears to glance up off the *pomum Adami* against the hyoid bone, and then back into the pharynx, which is usually laid open. Often the alæ of the thyroid cartilage are variously hacked and cut, as in a case which I now have under observation, where a second cut, lower down, severed the crico-thyroid membrane and left the upper end of the trachea open. This lower cut was utilized as a tracheotomy opening. The patient has now quite recovered. The arteries most likely to be injured are the superior thyroid and facial; more rarely the lingual, which is protected by the hyoid bone. The vocal cords generally escape injury, though, if recovery takes place, there is often alteration in the voice, due to deformity of the thyroid cartilages or to injury to the recurrent laryngeal nerve.

The risks in cut-throat are, first of all, hemorrhage, next broncho-pneumonia, and, lastly, septicæmia or pyæmia.

Hemorrhage.—Hemorrhage may vary in degree from a rapidly fatal one, which will not require treatment, to the severance of a small vessel, which has only to be secured to prevent further trouble on this score. Arterial hemorrhage is usually more speedily fatal than venous, but, as we have before said, the latter is more troublesome to treat. The danger of concealed and secondary hemorrhage is very great in these cases, as the air passages and pharynx or œsophagus are often opened at the same time as the vessels, and much blood may escape in this way.

Broncho-pneumonia.—Broncho-pneumonia is, next to hemorrhage, the danger most to be apprehended in those cases where the wound penetrates the respiratory tract. It generally shows itself about the fifth day, and arises in two ways: (1) At the time of infliction of the wound, blood runs into the respiratory tract, and may do so in such quantities that it is not all coughed up. Or, the patient may lose consciousness (syncope) and the blood continue to run down the trachea into the bronchi. This blood clot in the trachea or bronchi may (and often does) subsequently become infected, and pneumonia—really a septic pneumonia—results. When one considers that the resistance power of these patients is practically nil, owing to loss of blood at the time of the injury, one can easily see how much to be dreaded this complication is. (2) A septic broncho-pneumonia may also arise from direct inhalation of air from a wound which has become septic, an occurrence which may take place at any time during the healing of such a wound, unless precautions are taken to prevent the inhalation of such germ-laden air by the patient. (See Treatment.)

Septicæmia and Pyæmia.—Septicæmia and pyæmia may of course follow directly upon infection of such a wound, but in these cases there is special danger of this result. The presence of the large vessels in the neck, the abundance of lymphatics, and the relations of the cervical fascia render the spread of septic conditions here very easy, and pus has not far to travel in any direction before reaching a vital spot or getting beyond our reach. The character of the patients who are the common subjects of cut-throat—melancholics and other insane persons—also renders it extremely difficult to maintain these wounds in an aseptic condition, if, indeed, they escape primary infection, which is unlikely, as neither the suicide nor the homicide pays much attention, as a rule, to the cleanliness of the weapons. The suicide, moreover, often does not wish to recover, and will tear off the bandages, tear open and infect the wound, refuse food, and otherwise do all in his or her power to prevent a favorable issue. Add to all this the lowered resistance of the tissues due to loss of blood, and it will readily be granted that in these cases the danger of septic complications is very great.

Other Complications.—These complications, which need only very brief consideration, are dyspnœa, dysphagia, aphonia, and œsophageal fistula.

Dyspnœa, often distressing, is due to œdema of the glottis or to an organized blood clot which may obstruct the trachea low down. Such a case I have just had: A lady, melancholic, cut her throat in bed at night and was found, next morning, unconscious from loss of blood. She was treated in the usual way (see Treatment) and did very well until about the fifth day, when she developed urgent dyspnœa, which was not relieved by ice-pack, inhalations, or drugs of any kind. Her pulse and temperature remained good, she was not markedly cyanosed, the wound (which was situated above the thyroid cartilage) appeared in good condition, and she could swallow without difficulty. This urgent dyspnœa lasted for twenty-four hours, and we were discussing the advisability of resorting to tracheotomy, to relieve the patient, when she was seized with a severe spasm of coughing, and expelled a hard, organized blood-clot, about half an inch long and having the circumference of an ordinary lead pencil. The relief was instant, and she gave us no further anxiety. This was evidently a cast of one of the lower respiratory passages, and the tracheotomy, had we done it, would have been quite useless. Permanent dyspnœa, requiring relief by permanent tracheotomy, may result from cicatricial stenosis of the larynx, which gradually ensues upon healing of the wound.

Dysphagia is a frequent and very troublesome complication of cut-throat, though the wound is usually so low that the epiglottis escapes injury, and therefore swallowing is possible. In one case, where this structure was severed, I was able by suturing to restore it to its place, and the result was good. But not uncommonly the administration of food by the mouth must for a time be stopped, as it simply comes out through the wound and increases the danger of sepsis. When the wound is repaired, feeding through a stomach tube can be safely and easily carried out.

Aphonia is another common complication. Either the vocal cords or the recurrent laryngeal nerve may be injured, and so aphonia may be produced; or the wound may open the trachea below the box of the larynx, and thus prevent the expired air from acting upon the vocal cords.

Œsophageal fistula has been mentioned as a result of cut-throat. It must occur rarely, as a wound capable of producing such a lesion in the œsophagus would in most cases be primarily a fatal one. A temporary pharyngeal fistula is common, but is not of special importance, as it always heals spontaneously.

TREATMENT.—Treatment should be directed primarily to controlling the hemorrhage. To this end all severed vessels should be tied, both ends being secured. It is rarely safe to close such a wound at first, as many of the vessels will have temporarily ceased bleeding because of the diminished arterial pressure due to loss of blood; but, later, these vessels may bleed again, and the surgeon should therefore be in a position easily and quickly to secure them. At first, therefore, it will be better to pack the wound with sterile gauze, after irrigating it with warm antiseptic solution, and to leave the clots in situ, if the patient is very weak. A careful watch should be kept for hemorrhage; shock should be combated by all available means; and measures should be taken to maintain free respiration (by tracheotomy or laryngotomy, if necessary). If the patient is very restless or excited, morphia should be given hypodermically, in fairly large doses, in order to secure rest. If the pharynx has been opened, food should be given, during the first two days, per rectum only, as to give food by mouth in such a case would contaminate the wound from within. Often the mental condition of these patients is such that rectal alimentation is the only available method of feeding them without the employment of undue violence or without causing harmful excitement.

As soon as the condition of the patient warrants it, an effort should be made to repair the wound and bring together the severed parts of the respiratory tract. Even in a severe wound, I feel sure that this can generally be done earlier than we have hitherto been taught. For the repair of the deeper parts no anæsthetic will be needed, and only when we come to deal with the skin incision will a small amount of chloroform or ether be required; and this is the last part of the operation and is quickly done. In fact, it is a distinct advantage to have the patient conscious when the operator is restoring the continuity of the tube of the trachea, larynx, and pharynx. The mucous lining of the trachea or larynx should, from time to time, be swabbed gently, or irritated with a cotton-tipped probe, which will excite reflex coughing and thus expel septic blood clots and mucus which have run down whilst the patient was bleeding freely and perhaps was unconscious. This lessens the risk of a subsequent broncho-pneumonia.

In the actual work of reparation, the most important thing is the careful suturing of the severed ends of the different extrinsic muscles of the larynx (thyro-hyoid, etc.). This best approximates the widely gaping structures in the wounds, and is much to be preferred to any effort to suture the bony or cartilaginous structures themselves. For this work I like best mattress sutures of iodized catgut. The severed ends of the depressor muscles of the hyoid bone (sterno-hyoid, omo-hyoid, etc.) must next be united in the same way, and so also must the sterno-mastoids, if they too have been injured. Cigarette drains, on either side, should be passed down to the main wounds in the larynx, in order to give free egress to any secretion from the pharynx or trachea. At this stage the patient should be put under light general anæsthesia, and the edges, often infected and irregular, of the skin wound should be trimmed evenly and cleanly, so that a proper suture line can be made. By this procedure we obtain a less unsightly scar and are more likely to get primary union. In the case of a lady who was under my care, the cosmetic result was excellent; the resultant scar could not be distinguished from that following Kocher's "collar incision" for goitre.

I would also, in all severe cases of cut-throat, lay particular stress upon early tracheotomy. Sometimes, as I have shown, the original wound may be utilized for this, and then all one has to do is to drop a tracheotomy tube into the trachea. But if this does not serve, I would strongly advise that an early tracheotomy be done, in order that it may thus be practicable to pack off the wound above, to secure the bleeding points, and then to close the wound at one's leisure, with the feeling that, in the mean time, the patient is not inhaling contaminated air and thus running the grave risk of an inhalation broncho-pneumonia. Experience amply teaches the value of such a proceeding as a routine practice. The tube should be kept in until all danger of suppuration in the wound is past. Not only are the lungs thus kept supplied with pure air, but the patients themselves soon learn the fact that, so long as the tube is in situ, it is not possible for them to speak. Thus, much harmful use of these damaged organs is prevented, and the patients are rendered less objectionable to their neighbors.

As soon as the danger of syncope is over, the patient should be kept well propped up, in a semi-sitting posture, and should be got out of bed as early as possible. Fluid diet should be allowed after the first forty-eight hours. At first, albumen water may be given tentatively, and then, if the patient can swallow, other fluids should be carefully tried, the dressings being always examined after each feeding, to see if any of the fluid has come through the wound.

Injuries to Nerves of the Neck.—As a rule, any accidental or purposely inflicted wound of the neck of sufficient depth to cut any of the large nerves would also sever the large arteries and so lead to a speedily fatal issue. But some particular nerve—say, the vagus or the sympathetic—may be injured accidentally or at an operation, or surgical relief may be sought from pressure symptoms caused by a tumor. It is necessary, therefore, that a few words should be said regarding the injuries to which each important nerve may be subjected.

1. *Vagus.*—Inclusion of this nerve in a ligature or clamp may give serious or even fatal results. The heart stops first, and then failure of respiration follows. The nerve may also be injured by a stab or a bullet wound, but this injury is then usually associated with other injuries demanding more prompt attention. An analysis of the statistics of recorded cases of injury to this nerve, as given by von Bergmann, shows a mortality of fifty-two per cent; but it would be very difficult to say just what percentage was due to the nerve injury alone, so many other structures being simultaneously injured and so many other complications ensuing. Indeed, von Bergmann concludes that none of these deaths was due to the injury done to the nerve, and says that "unilateral resection of the vagus may be considered devoid of danger." The laryngeal symptoms which follow section of the vagus are always most pronounced. If this nerve be divided below the origin of the superior laryngeal nerve, there would be less danger of septic pneumonia, inasmuch as the sensitiveness of the larynx would still be maintained; but the alteration of the voice would be most marked, owing to the vocal paralysis resulting from interference with the fibres going to the recurrent laryngeal branch of the vagus. Of course, it often happens, especially in aneurysms and other forms of thoracic tumors, that the alteration of the voice is due purely to pressure on the inferior laryngeal nerve itself, and not on the vagus. (See article on "Surgery of the Thyroid Gland.")

2. *Sympathetic Nerve.*—Injury to this nerve cannot of itself be considered a serious matter, and is usually concomitant with some other condition of grave import. It has been frequently resected, even bilaterally, by surgeons in the hope of producing a cure for epilepsy and Graves' disease, without any untoward effect upon the patients, and also, as a rule, without curing these diseases.

3. *Spinal Accessory Nerve.*—See the article on "Torticollis" in Volume IV.

4. *Brachial Plexus.*—These trunks may be injured, but usually the wound,

if accidental or homicidal, proves fatal from other complications. I remember to have seen one case of forcible avulsion of the upper extremity where the brachial plexus was severed.

Treatment.—As a rule, any severed nerve may be safely sutured with the hope of a good result, and nerves in the neck are no exception to the rule. (See "Surgical Diseases and Wounds of Nerves," in Vol. II.) But, as the result does not depend upon the *immediate* repair of the nerve, it is generally good practice to wait and make sure of the particular nerve trunk which requires suturing. The symptom of paralysis is often recovered from as the traumatic neuritis subsides, even when it was so pronounced that a diagnosis of severed nerve was made at the time of the injury.

Injuries to Muscles of the Neck.—An effort should always be made, where it is feasible, to suture these wounds of muscular tissue. With this object in view one should not hesitate to enlarge the original wound. A mattress suture of good-sized chromicized or iodine catgut is, perhaps, preferable, and afterward care should be exercised in arranging the dressings in such a manner that no extra strain shall be immediately thrown upon the sutured muscle.

III. DISEASES OF THE BLOOD-VESSELS OF THE NECK.

Arterial Aneurysms.—Etiologically, aneurysms of any of the larger arteries of the neck must be regarded as either spontaneous or traumatic. By this is meant, broadly, that, in the spontaneous form, the localized dilatation of the vessel wall which constitutes the aneurysm is due to some weakening of the coats of the vessel at the site of such dilatation—a weakening caused by local sclerosis, syphilis, alcoholism, etc., whereas, in the traumatic form, the vessel walls dilate at some point because of injury to them at that point (*e.g.*, stab wounds, blows, crushes, garrotting, etc.). It may of course happen that both these factors are present at the same time—as, for example, when an apparently insignificant injury to the neck produces aneurysm of some vessel in a patient who is already the subject of arteriosclerosis. As a rule, traumatic aneurysm develops soon after the injury which caused it, whereas aneurysm due to disease of the vessel walls would be more likely to develop slowly. Still, one often finds the reverse to be the case. A slight strain thrown upon an already weakened vessel wall may suddenly produce spontaneous aneurysm, whereas traumatic aneurysm may develop only some time after the injury which caused it, the scar of the vessel coats requiring time to dilate sufficiently to produce aneurysm.

As regards the liability of the different large vessels to be affected, statistics show that the carotid vessels are more often involved than either the subclavian or the innominate, and the common trunk of the carotid more often than either of its terminal branches. Aneurysms of the vessels of the neck are more common in men than in women and often occur in youth.

Aneurysm of the Common Carotid Artery.—As there is, normally, a slight ampulla in the artery just before it bifurcates into its internal and external branches, it would seem as though the walls were thinner at that point. Here, then, is the most common site of aneurysm, and many cases of so-called aneurysm of the branches (internal and external) are really but extensions upward of the primal dilatation of the upper part of the common trunk. Next in frequency will be aneurysm of the lower part of the trunk—a variety of aneurysm which is difficult to diagnose from, and often is complicated with, aneurysm of the subclavian or the innominate artery.

Symptoms.—The presence of an elongated pulsating tumor in the carotid region, either following injury or in a patient whose personal history might lead one to infer possible disease of the vessel walls, would make one suspect aneurysm. If auscultation reveals a systolic murmur, and if pressure causes the tumor to disappear, only to reappear when the pressure is removed, one may be almost certain of the diagnosis. But blood clot in the sac might interfere with both of these signs. There might be a weakening of the temporal pulse on the affected side, and also evidences of interference with the cerebral blood supply (headaches, vertigo, temporary paralyses, insomnia, etc.); but the circulatory changes which would produce these symptoms soon equalize themselves, and hence they may be absent at the time of the examination of the patient. The size of the tumor may vary much, and so may its apparent shape, owing to overlying structures. As the aneurysm increases in size evidences of pressure on the surrounding structures make their appearance. Among such evidences of pressure upon the nerve trunks in the neck may be mentioned dyspnœa, dysphagia, alteration of voice from pressure upon the recurrent laryngeal nerve, and pain, which is often referred to other parts.

Diagnosis.—The diagnosis can be made without difficulty if pulsation and a bruit are present; but, if these symptoms are absent, it may be difficult to distinguish between aneurysm and enlarged lymph nodes of the sarcomatous type, especially as the node which lies on the carotid sheath, at the bifurcation of the artery, is occasionally the focus of sarcomatous changes.* Hæmatomata are often difficult to differentiate from aneurysms. The practice of using the aspirating needle for the purpose of establishing a diagnosis is not to be commended, both because it is dangerous and because the findings are not reliable, as one might get blood in either case, and therefore be none the wiser.

Prognosis.—The prognosis is always grave. One never knows how thin the sac is, nor into what neighboring viscus it may suddenly burst, with probably fatal effect. While the aneurysmal tumor may in some instances long remain apparently stationary, yet the causes which produced the trouble are probably still present, and spontaneous cure is not to be expected, though such cases are on record. The discomfort of the pressure symptoms may force the patient to seek relief by operative measures.

Treatment.—Treatment will obviously depend upon the view one takes of the etiology of the condition in any given case. If the aneurysm has developed spontaneously, and if it is due to syphilis, a course of antisyphilitic treatment should be tried, a careful watch being kept meanwhile of the tumor. In advanced cases of arteriosclerosis it is also perhaps better to try some form of palliative treatment. Absolute rest and a restricted dry diet should be faithfully tried in these cases, which are eminently unsuited to surgical treatment. Potassium iodide in small doses, given for a long period, occasionally seems to give relief, as it tends to lower the blood pressure. In traumatic aneurysm, on the other hand, surgical treatment should be early resorted to. In the majority of cases of carotid aneurysm it is certainly the only treatment; and, besides, surgical emergencies are always liable to arise, even in cases in which a cure by medical treatment and rest seems most promising.

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* Cf. Deutsche Zeitsch. f. Chir., Dec., 1908, pp. 327 *et seq.*

It is well, I believe, before discussing in detail the surgical treatment of aneurysm of the common carotid artery, to get a clear idea of the principles underlying treatment of aneurysms in general. A cure of these conditions may be obtained in several ways: by inducing the formation of a blood-clot in the sac; by preventing the blood from reaching the sac at all, or only through collateral channels, as in proximal ligation of the vessel (Hunter, Anel); and by ligating the vessel both above and below the tumor and then dissecting out the sac or laying it open (Antyllus). Of these three methods the last affords the surest means of curing the trouble. In the first method the expectation is that the deposit of layers of fibrin over the inner surface of the walls of the sac will reinforce them to such a degree that rupture will not occur, and that then, as the fibrin becomes organized, contraction will take place and diminution in the size of the tumor will result. This is the end hoped for by the rest and diet treatment (Valsalva, Tuffnell, and Balfour). Surgically, the same result may sometimes be attained by slowing the blood stream, either by digital pressure upon the vessel at some point proximal to the tumor, by ligating the vessel on the distal side of the tumor, by irritating the intima through the introduction, aseptically, of a coil of fine wire into the sac, or by introducing needles into the tumor and scarifying the intima (as practised by Macewen).

There are many modifications of these methods: but the three mentioned represent, in the main, the resources of surgical treatment. How will these apply in the case of aneurysm of the common carotid? It is evident that the treatment must be adapted to the particular case. If the aneurysm be high up, one may try pressure, or proximal ligation, or excision; but if it be low down (near the innominate or subclavian), distal ligation and compression are alone available, so far as the carotid itself is concerned. Otherwise the treatment is the same as for aneurysms of the subclavian or of the innominate artery.

Pressure, in the case of an aneurysm of the upper part of the common carotid, must be applied below the sac, and is best done by the finger compressing the vessel against the carotid tubercle (transverse process of the sixth cervical vertebra) for two or three hours each day. It is an extremely painful procedure for both patient and operator, is difficult to do, and the results are not always satisfactory. Still some cases have been cured: and Billroth's case is most instructive, both from the point of view of results and from that of the various cerebral symptoms resulting from interference with the blood supply to the brain. If this method fail, or if it is not possible to carry it out, *ligation* should next be tried, preferably below the sac. Here we must face the results of sudden occlusion of one of the large vessels supplying the brain, and, as Horsley (Address, British Medical Association, Toronto, 1906) has shown, this is a real danger. But the occlusion may previously be established by compression, and in young persons, so far as I have observed, the resulting cerebral disorder is never serious and usually is quite transitory. In older people, especially those whose blood-vessels are atheromatous, such prolonged compression may well cause serious and permanent results. Moreover, a rapidly restored collateral circulation may re-establish the aneurysm. Therefore, if the case be a favorable one for the method (young person or recent aneurysm), preference should be given to the radical operation of Antyllus. In carrying out this operation one should first ligate the artery below the sac and subsequently its terminal branches above (*vide infra*), the removal of the sac and its contents being left to the last. This dissection of the aneurysmal tumor is often a most difficult procedure, on account of the structures involved in the carotid sheath; especially must the nerves, pneumogastric and sympathetic, be avoided. The vein on the affected side will generally also require ligation, as it is very apt to be torn in the attempt to separate it from the sac. To escape the great difficulty presented by adhesions, it is often better to lay open this sac and dissect it out from the inside. Strict asepsis, as a matter of course, must always be aimed at. The plan of excising a portion only of the sac, after temporary ligature, and attempting by suture to restore continuity and patency of the vessel (Matas' operation) should not be risked here, although it is very suitable in aneurysms of the arteries of the extremities. (See author's article in *Annals of Surgery*, February, 1908.)

Ligation of the Common Carotid Artery.—Ligation of the common carotid artery is usually done at either one of two points, viz.: (1) just below the point where it bifurcates into its external and internal branches, or (2) near its point of origin below. The former is the easier operation of the two, especially in a thin patient, though it may be rather difficult in a stout plethoric subject.

An incision, 5 to 10 cm. (from two to four inches) in length, according to the amount of subcutaneous fat, should be made along the anterior margin of the sterno-mastoid muscle, the centre of the incision corresponding to the level of the cricoid cartilage. Upon dividing the two layers of fascia, with the intermediate platysma myoides muscle, we come upon the deep muscular guide, the tendon of the omo-hyoid muscle, which runs across the incision in front of the carotid sheath. This tendon may be pulled either up or down with a blunt hook, and the carotid sheath opened toward its inner side, to avoid wounding the internal jugular vein which lies in the sheath with the artery, but external to it. While they are not likely to be seen at the operation, it should not be forgotten that the following important structures are in close relationship with the common carotid artery:—In front, the descendens noni nerve and the sterno-mastoid artery; behind, the sympathetic and vagus nerves and the inferior thyroid artery.

The artery is carefully cleaned only at one point by a blunt dissector, but should not be lifted from its sheath, and a Macewen needle (right or left, as may be needed), threaded with a ligature, should be passed between the artery and the vein, *i.e.*, from without inward, care being taken to keep the blunt tip of the curved needle always close to the walls of the vessel in going around it, so that there may be no danger of including any other structure in the ligature. The ligature having thus been passed around the artery, it should not be tied until one has ascertained to a certainty, by pressure upon the vessel between the tip of the finger and the ligature held taut, that pulsation is controlled in the distal part of the artery. Personally, I prefer silk as a ligature material here. It should be as fine as will serve, and, after the knot has been tied, the ends should be cut short and the wound closed without drainage and preferably sealed with a collodion dressing.

Ligature of the common carotid between the two heads of the sterno-mastoid muscle is carried out by a vertical incision about 5 cm. (two inches) long in that position, and extending down to the clavicle. The large vein exposed will be the jugular, and this, with the clavicular portion of the sterno-mastoid muscle, must be gently retracted outward, while the other portion of the muscle, with the depressor muscles of the hyoid bone, are retracted inward, thus exposing the artery. The vagus nerve will lie behind the vessel, and great care must be taken not to enclose it in the ligature, which should be passed in the manner already described.

Temporary Ligation of the Common Carotid Artery.—Temporary ligation of the common carotid or any other artery may at times be indicated. This will be accomplished by exposing the vessel in the manner described above, and carefully passing around it a rather coarse silk ligature. Then two short pieces of sterilized rubber tubing, not much larger in calibre than the vessel itself, should be laid parallel to the artery and within the loop of the surrounding ligature. As a last step the ligature should be tightened, but only sufficiently to control the pulsation. The pieces of tubing and the ligature are subsequently removed and the wound is closed in the manner described above. One of the indications for a temporary ligation of the common carotid is the necessity of controlling hemorrhage while operating about the tonsils and fauces, or that of checking hemorrhage while an effort is being made to control a wound of some vessel higher up.

Aneurysm of the External Carotid Artery.—Aneurysm of this artery is usually of traumatic origin, and very difficult to differentiate from other tumors about the angle of the jaw. Its increasing size and pulsatile character will be the best guides. The treatment by compression should always be tried and will be best accomplished by graduated pressure with the finger upon the common carotid at the carotid tubercle. It must be remembered, however, that the collateral circulation through the opposite external carotid and the internal carotid will supply the tumor with blood. If compression fails, and if also simultaneous ligature of the internal carotid proves of no avail, proximal ligature, preferably of the external carotid itself, or, if that be impossible, of the common trunk, will then be advisable, although a favorable result is scarcely to be expected until the internal carotid of the same side and possibly the external of the opposite side shall have been ligatured.

Ligation of the External Carotid Artery.—Ligation of the external carotid artery is not by any means as easy as ligation of the common carotid, but the after-effects are much less to be dreaded, and, aside from the danger of sepsis, statistics show that the operation is practically devoid of danger. The best place for applying the ligature is at a point one finger's breadth below the level of the angle of the jaw; and the vessel may be reached by a vertical incision, along the anterior border of the sterno-mastoid muscle, extending from the angle of the jaw down to the level of the hyoid bone. In the lower part of this wound the facial vein and some of the thyroid veins will appear and must be pulled down; in the upper part of the wound it is necessary to identify, and pull upward, the posterior belly of the digastric muscle, and with it perhaps the hypoglossal nerve. Next, the internal carotid artery and the jugular vein should be retracted toward the sterno-mastoid muscle. This will expose to view the external carotid artery, and the ligature should then be passed around it from without inward. Kocher advises ligating the vessel at a point one finger's breadth below the angle of the jaw, in the posterior part of the curved incision, which he prefers for exposing the submaxillary triangle of the neck. It is obvious that the internal carotid may be ligated through the same incision, as may also most of the large branches of the external carotid at their origins.

Aneurysm of the Internal Carotid.—Judging from the paucity of literature, this must be a rare condition. It simulates tonsillar and pharyngeal growths. The treatment is that for aneurysm of the external carotid, *mutatis mutandis.*

Aneurysm of the Innominate Artery.—Aneurysm of this artery is practically always of spontaneous origin and is indicated by the development of a pulsatile tumor at the lower part of the right anterior triangle of the neck. One of the earliest signs may be an alteration in the voice, due to pressure on the right recurrent laryngeal nerve. "Tracheal tugging," as pointed out by the late Dr. George Ross, of Montreal, may also be present, and will be felt synchronously with the pulse-beat if one holds up the larynx lightly with the finger and thumb. These signs may be present even before the tumor manifests itself above the right sterno-clavicular articulation, but will not serve to differentiate it from aneurysm of the arch of the aorta where they are also present. The pressure symptoms, in a rapidly enlarging tumor in this locality, are generally most marked.

In some cases the arteries (right carotid and subclavian) which emerge from the aneurysmal tumor may cease to pulsate, owing to obliteration; while in others, paradoxical as it may seem, the enlarging tumor may press upon and obliterate the left carotid or even the left subclavian. These points are important to remember in a differential diagnosis, inasmuch as a weakening of the right radial pulse, while the pulse in the right temporal remains unchanged, would indicate subclavian aneurysm; whereas, if both pulses were found to be diminishing in volume *pari passu*, there would be good ground for believing that the aneurysm involved the innominate.

The treatment falls largely under two heads. First, the large vessels (right subclavian and common carotid) that emerge from the sac, should be ligated on the distal side. One must first be sure that the left carotid is patent. (*Vide supra.*) It is better to ligate both simultaneously, and thus leave the innominate trunk as a cul-de-sac which will speedily fill with organizing blood clot. Second, one may elect to follow Macewen's plan of causing coagulation by inserting a needle in the sac, scarifying the intima as much as possible with the point and then withdrawing it. This procedure is to be repeated every second day for a couple of weeks, or until some improvement is noticed. Or again, one may insert two needles into the sac, and pass a galvanic current through them, thus producing clotting by electrolysis. Still another method is to introduce fine wire into the sac, in the hope that by this means coagulation of the blood may be induced. It is needless to say that, whatever plan be adopted, stringent asepsis is essential to any favorable result.

The risk attending the use of a general anæsthetic should always be borne in mind, and this is one point in favor of the needle operations, which do not require the employment of an anæsthetic.

Aneurysm of the Subclavian Artery.—Aneurysm of the subclavian artery is rarely located in the neck alone, and therefore this subject will be more properly considered in the article on "Surgery of the Lungs and Mediastinum," in Vol. VII. The only radical treatment is ligation of the vessel.

Aneurysm of the Vertebral Artery.—Aneurysm of this artery has been observed in rare instances, as a result of a stab wound. The only treatment is proximal ligation of the vessel.

Ligation of the Vertebral Artery.—Anatomically considered, the vertebral artery is a difficult artery to ligate, and many different plans have been advocated by different operators for performing the work satisfactorily. One thing that increases the difficulty is the ease with which one may confound this vessel with the inferior thyroid. The vertebral artery is usually ligated (*vide infra*) before it enters the canal in the sixth cervical vertebra and therefore at a point quite close to its origin.

The method advocated by Kocher' appears to me the simplest and surest. An incision is made along the anterior border of the sterno-mastoid muscle, from the level of the cricoid well down to the suprasternal notch. The platysma and fascia having been divided and all bleeding points ligated, the carotid tubercle (the transverse process of the sixth cervical vertebra) is felt for, as we know that the artery enters its bony canal just here and it is at this point that we wish to apply the ligature. The sterno-mastoid muscle and carotid sheath are retracted outward and the inferior thyroid artery is pulled gently down; and then, by making a vertical slit in the prevertebral fascia between the inferior thyroid artery below and the carotid tubercle above, we shall expose to view the vertebral artery as it runs directly into the bony tubercle. Sometimes it is necessary to pull aside a few fibres of the longus colli muscle which overlap the artery in this locality.

Mikulicz recommended that, in those cases where the ordinary anatomical relations were distorted by tumors or other pathological conditions, the clavicular origin of the sterno-mastoid muscle should be divided and turned aside, in order freely to expose the origin of the vessel. The artery might then be ligated at that point and the severed muscle subsequently united by sutures.

Helferich advises cutting down upon the carotid tubercle in the anterior triangle of the neck, and removing carefully the tip of this bony process (after denudation of the periosteum) by means of rongeur forceps or bone pliers until the artery is laid bare in the vertebral canal. When this course is followed and the artery is ligated in its bony channel, the operator will avoid all possible chances of making a mistake.

Venous Aneurysms.—In addition to the true forms of aneurysm described above, one may see, in rare instances, saccular communications between the large arteries and their corresponding veins—the so-called arterio-venous aneurysms, in which the conditions are those of an aneurysmal varix. These are usually the result of traumatism, though they may follow suppurative disease which interferes with the normal support of these vessels at a given point. Such aneurysms usually appear about one week after the infliction of the injury—most commonly a stab or bullet wound,—and their mode of development appears to be the following:—Both the artery and the vein (for example, the carotid and the internal jugular) are wounded at the time of injury, and the pressure of the resulting hæmatoma between the two vessels is sufficient to hold in check the weakened flow of blood from the almost exsanguinated patient. The slight pressure resulting from closure of the external wound prevents further hemorrhage at the time. In the course of a week or ten days the plug of intervening blood clot liquefies and discharges into both vein and artery, thus establishing a communication between the two; an intervening sac representing the site of the old hæmatoma. This is a true arterio-venous aneurysm. But the disease may develop in quite a different manner, as when the old hæmatoma contracts, and the small openings in the vein and artery coalesce, establishing thus a direct communication between the vessels, without any intervening sac. The condition then will be one of *aneurysmal varix*, which gives symptoms quite different from those which characterize the other condition, and usually does not require treatment. In the one case (that of a varicose aneurysm) there is always the presence of a definite, and generally pulsatile and irregular tumor, which does not entirely disappear upon pressure, while in the other (aneurysmal varix) there will be an ill-defined swelling only, irregular in outline, which disappears upon pressure. On auscultation the purring sound is more marked in the aneurysm than in the varix, while in the latter case the bruit is more likely to be propagated along the course of the vessels. The patient himself often complains of the continuous noise in the tumor of an aneurysm, and the presence of this symptom often preys upon his mind and produces melancholia. As a rule, these and other symptoms of interference with the circulation tend to disappear spontaneously.

Treatment.—Treatment is not often called for, and one should always wait long enough to ascertain whether the symptoms will not spontaneously disappear. Should, however, the continuation of troublesome symptoms or the rapid increase in the size of the tumor indicate interference with the circulation, by far the best method of operation is that of Antyllus, which insures excision of the sac. This means, of course, ligating both the vein and the artery, above as well as below the sac. In this condition one might do the Matas operation (*Annals of Surgery*, February, 1903), *i.e.*, attempt restoration of the lumen of the vessels by suturing the openings, after excision of the sac; temporary ligation of the vessels being employed to keep the field of operation dry and to check hemorrhage.

IV. INFLAMMATORY AFFECTIONS OF THE NECK.

A. Acute Inflammations.

Boils and Carbuncles.—As both of these affections are commonly caused by the introduction, from without, of pyogenic bacteria into the hair follicles or sebaceous glands, one would naturally expect that the exposed situation of the neck and the irritation caused by the clothing would make these affections common here. And such we find to be the case, especially in adult males, the back of the neck being the favorite site of carbuncles. Once the infection is established and pus is formed, the free supply of lymphatics in the neck carries the infection to neighboring lymph nodes, where abscesses may develop and constitutional symptoms rapidly show themselves. The strength of the cervical fascia, when stretched by these inflammatory processes, induces acute pain.

Boils.—Although etiologically identical, boils and carbuncles differ from each other very much clinically. The infection, in the case of a boil, has a tendency to spread from one hair follicle to another, but always, I believe, from without. Hence there often arises a chronic condition of furunculosis. Of course, in this infection, as in others, the resisting power of the patient plays an important part, and one which should never be neglected in treatment. But the local treatment is, at first, all-important. An effort should always be made to control the first infection of the hair follicle, and this may be done by introducing into the follicle a fine cautery point at white heat, by opening the pustule with a fine tenotome and swabbing the interior with pure carbolic acid, or by injecting into it a few drops of pure carbolic acid and then carefully closing the opening with collodion until the time arrives for making the next application. Such treatment would lead to a material diminution in the number of those chronic cases of furunculosis which are so troublesome to patient and surgeon. In other words, the proper course is to prevent the escape of the staphylococcus from an inflamed hair follicle (boil), and by so doing we shall prevent infection of other follicles. Kill the germ in its first retreat. But the medical man usually sees these cases when the furunculosis has become general; at which time the best treatment is to open freely all the suppurating tumors, and then to apply moist antiseptic dressings (carbolic acid, 1 : 100; corrosive sublimate, 1 : 3,000), and these dressings must be kept up faithfully until the skin is quite disinfected. It is marvellous how long the skin appears to retain the infection; but I am convinced that often the new outbreaks represent re-infections of a part whose power of resistance is diminished by both disease and treatment. A change of scene and climate often aids marvellously in the cure of these conditions, and general tonics (iron and cod-liver oil) are always indicated in anæmic patients.

Carbuncles.—In this affection the clinical picture is quite a different one. The infection here does not tend to come to the surface, but spreads subcutaneously from follicle to follicle, or from one sebaceous cyst to another. Hence we get the picture of a rapidly forming phlegmon, followed by necrosis of the whole part, with severe constitutional symptoms, which, if neglected, not seldom end in death. The surgeon should never temporize with a carbuncle. Early and free incision, from good skin on one side to good skin on the other, with perhaps cauterization, should be an absolute rule. The crucial incision is generally needed, to expose thoroughly all the affected tissue. After the wound has been curetted, it should be left open and packed with moist antiseptic dressings (carbolic or sublimate), and the separating sloughs should be removed with dressing forceps as soon as they form. If the disease is well advanced when first seen by the surgeon, it may often be necessary to excise the whole necrotic area, down to the fascia, and the resulting granulating wound may subsequently require to be closed by skin grafting. Unless contra-indicated, the employment of a general anaesthetic enables one to deal better with carbuncles, whereas a local anæsthetic is generally sufficient for boils. In every case a careful examination of the urine for sugar should be made, in order to eliminate the well-known relation between furunculosis and diabetes. If sugar is present, obviously the treatment will be more medical than surgical, and the prognosis is much more grave. The use of the cautery in incisions lessens the danger from hemorrhage and the danger of infection from freshly divided surfaces. (See also Vol. II., pp. 127 and 307.)

Erysipelas.—Erysipelas of the neck differs little from erysipelas elsewhere, except that here it seems to spread more rapidly in the loose tissues which are so well supplied with lymphatics, and there is also here perhaps greater danger of septic phlebitis and subsequent meningitis.

Suppuration and Abscess.—Acute suppurative conditions of the neck may arise in various ways. The pyogenic organism may be introduced directly into the tissues, as a result of injury either of the skin or of the mucous membrane of the mouth or air passages; or it may find its way to the parts indirectly, being conveyed by the lymphatic vessels from a septic focus in some other part of the body—for example, from an otitis media, an alveolar abscess, a tonsillitis, etc. Often the cervical suppuration is delayed, and if, under these circumstances, the original source of infection (not infrequently quite distant) shall have in the mean time quite healed, one may be at a loss to account for the infection. But the acute character of the infection (staphylococcus or streptococcus) usually renders it easy to distinguish it from any of the chronic suppurative conditions which may often be the predisposing cause of the acute condition.

The course of acute suppuration in the neck, with the formation of an abscess, is generally rapid, as would be expected from the plentiful lymphatic supply; moreover, one must understand the anatomical relations and attachments of the different layers of the cervical fascia, in order properly to anticipate the probable course of the suppurative processes.

(See the article on "Surgical Diseases and Wounds of the Lymph Nodes and Vessels," in Vol. II., for a description of these parts.)

SYMPTOMS.—Acute suppurative conditions usually manifest themselves in two ways, viz., either in the form of an acute suppurative œdema (*vide infra*, "Ludwig's angina") or in that of an abscess, which may rapidly burrow and spread between the layers of the cervical fascia. Sometimes (though rarely in acute conditions) the infection spreads from one group of lymph nodes to another. The distinction between these two classes of cases is of practical importance, as early and free incisions into the acute œdematous areas are absolutely imperative, whereas the abscesses may be evacuated through a much smaller incision, preferably in a dependent position and generally safest done by Hilton's method.

A word or two here in explanation of what is meant by "Hilton's method of opening abscesses." Instead of plunging the bistoury boldly into the abscess cavity, on the one hand, or carefully exposing the abscess by open dissection, on the other, Hilton maintains that, in certain positions, less risk is incurred if the original incision extends down only to the fascia. He therefore recommends that the fascia should not be incised, but merely punctured, and that through this punctured opening a fine-bladed pair of Pean's artery forceps (or, better still, Bigelow's sinus dilator) should be introduced and used as a director or probe until pus is found. The forceps or dilator should then be opened as widely as convenient without using undue force, and withdrawn from the wound, thus opening the abscess thoroughly and at the same time pushing aside, uninjured, important structures which might surround it. This method is particularly applicable in the evacuation of collections of pus in the neck, and especially so in opening a retropharyngeal abscess behind the sterno-mastoid muscle.

Submaxillary Suppuration: Ludwig's Angina.—Ever since the publication (in 1836) of Ludwig's article, in which was given the clinical picture of a form of submental suppuration, in several respects quite different from the other forms of cervical suppuration, an active controversy has been going on as to whether this is, as Ludwig maintained, a distinct disease or merely a phase of cervical suppuration. A study of the infective bacteria fails to settle the question, as these organisms range from staphylococcus to B. coli communis, probably a majority being streptococci. In a noteworthy discussion of the subject by the French Surgical Society, in 1892, Nélaton and Delorme took opposite views of the question, the former denying it a place as a distinct disease, whereas Delorme maintained that it was a true sublingual phlegmon, originating in the submental lymph nodes, spreading back to the pharynx and larynx, and thus rapidly proving fatal, either by acute œdema of the glottis or by inciting a septic inhalation-pneumonia. In 1893 Poulsen also argued that the inflammatory process spreads through the lymphatics from the superficial tissues to the pharynx and larynx. His statistics clearly proved that the disease chiefly affects young adults, and that primarily the infection is most often communicated from the mouth. Semon (1895) maintained that Ludwig's angina is, as regards the infection, identical with, and secondary to, acute septic inflammations of the throat, and is in reality a sequel of such conditions.

Symptoms.—Whatever views may be held as to the etiology of this particular form of submaxillary infection, the symptoms present a fairly constant picture. Following upon some slight infective condition of the mouth or pharynx (*e.g.*, carious teeth, or a sore throat), the patient suddenly becomes septic, exhibiting rigors, fever, great mental depression, and distressing respiration. The tissues between the chin and hyoid bone rapidly become swollen, tense, very tender, and œdematous, and the tongue is pushed up against the roof of the mouth and cannot be protruded. The picture is certainly one of sublingual phlegmon, as Delorme maintains. The teeth can be separated only to a slight degree, the breath soon becomes peculiarly foul, and there is generally dribbling of fetid saliva from the angles of the mouth. Œdema glottidis may supervene at any time, and in such a case prompt tracheotomy will be necessary to prevent a rapidly fatal issue.

Prognosis.—The prognosis is generally grave. If not treated, only a minority of the cases will recover by spontaneous localization and evacuation of the abscess. Even tracheotomy does not save all cases of œdema of the glottis, as the danger of a fatal septic pneumonia must still be faced. It is this tendency to rapid necrosis of the deeper tissues, and more especially those of the larynx, which makes the surgeon so dread this affection.

Treatment.—Early and free incisions between the chin and the hyoid bone should always be resorted to. Never be satisfied with incisions which only go down to the fascia, but open this freely by Hilton's method (*vide supra*) or by the use of a blunt dissector. The best incision is one similar to that used for dissecting out the submaxillary triangle, viz., one that extends from the angle of the jaw down to the great cornu of the hyoid bone and then up to the symphysis menti. Repeat this on the other side, if necessary. When the skin flaps are deflected the muscles can be separated and an opening made into the sublingual tissues, where the pus will be found.

The deeper structures must always be exposed and the exit of the inflammatory products through drains assured; otherwise, they will gain entrance into the deeper lymphatics and thus fatal œdema of the larynx will ensue. The patient should be kept in an atmosphere of warm, moist air saturated with the vapor of Friar's balsam, or eucalyptus; and the open wounds should be treated with moist antiseptic fomentations. The patient's strength should be maintained by liquid food, given through a tube, if necessary, and stimulants should be freely given. Delirium is often present, and it may be found desirable to administer an opiate.

Other forms of submaxillary suppuration, not seldom seen, are really instances of suppurative adenitis, either of the lymph nodes at the angle of the jaw (which have become inflamed as a result of some infective condition of the tonsils, or from ulceration of the gums at an eruption of a wisdom tooth), or of the submental group of nodes, the infection in the latter case coming from some focus situated on the lip or on the tip of the tongue. These cases require the treatment which is suitable to adenitis in other localities.

Retropharyngeal Abscess.—Retropharyngeal abscess requires a brief notice here. It usually develops in an acute manner, and is secondary to an infective pharyngitis; only rarely does it represent an extension of peritonsillar suppuration. When chronic, it is due to caseation and suppuration of some of the retropharyngeal lymph nodes as a result of tuberculous infection.

The first symptom is usually dysphagia, and examination shows that this difficulty is due to a swelling or bulging forward of the back wall of the pharynx. If the disease is allowed to go on, the pus burrows down behind the strong prevertebral fascia and may cause serious and even fatal dyspnœa by pressure upon the air passages lower down. The abscess, if allowed to become sufficiently tense, may burst spontaneously into the throat, and there are instances on record of patients having been suffocated in this way during sleep.

The abscess should be evacuated early, and if it is of some size it will be better to approach it by way of the neck. An incision, 4 cm. (1¾ inch) in length, from the tip of the mastoid process, should be made along the posterior border of the sterno-mastoid muscle. The incision is carefully deepened until the deep fascia is opened at one point, and then a sinus dilator or artery forceps (closed) is insinuated between the vessels and the tips of the transverse processes of the cervical vertebræ, which can easily be felt in the wound with the finger. The instrument is pushed in until the pus flows, and the blades are then opened vertically and withdrawn (Hilton's method); the cavity is drained by a small rubber drainage tube. Care should be taken that the end of this tube does not press upon the wall of the pharynx, as it might thereby cause erosion and perforation. The tube should be left in place for a few days until drainage ceases; the wound will then heal and the abscess cavity will be obliterated, as in similar conditions elsewhere.

The operation just described presupposes that the patient can be given a general anæsthetic. But sometimes the dyspnœa is so urgent, or the danger of the abscess bursting into the mouth and suffocating the patient while taking the anæsthetic is so great, that it is quicker and safer to evacuate the abscess through the mouth, by puncturing the back wall of the pharynx. After a self-retaining mouth-gag has been put in position, the patient should be inverted, or should at least have the head much lowered, and then the surgeon, with his left forefinger hooking down the tongue, opens the abscess cavity freely in the middle line and allows the pus to run out of the mouth. The inverted position should be maintained until the pus has practically all escaped. The after-treatment consists in the frequent use of a warm antiseptic mouth wash and the administration of carefully selected soft foods.

Acute Inflammatory Conditions of the Carotid Sheaths.—Of the inflammatory processes in the neck these rank next in frequency to submaxillary inflammations. They generally appear as sequelæ to the exanthems, notably scarlatina, though other causes may produce them—as, *e.g.*, otitis media, carious teeth, tonsillitis, ozæna, etc.

Symptoms.—The first symptom is usually a painful, tense swelling under one, or both, of the sterno-mastoid muscles; and with this rigors and fever are soon associated. If one side only be affected, the position of the head will be identical with that assumed in torticollis, owing to infiltration of the muscle sheath. Œdema, dysphagia, and dyspnœa develop later, if the disease remains untreated. If pus forms it may point anywhere along the course of the sterno-mastoid muscle or may even follow the fascia and appear above the clavicle or in the axilla. Rarely, it points posteriorly, and may then work its way down, in front of the pretracheal layer of cervical fascia into the anterior mediastinum.

Prognosis.—The prognosis will depend largely upon the plan of treatment pursued. Most of these patients, under early and intelligent surgical treatment, recover, so far as this complication alone is concerned; but, should an abscess develop and be allowed to burrow down, the prognosis would be much more grave. The danger of septic phlebitis in the jugular vein is always present, and should be promptly treated, to forestall temporo-sphenoidal abscess.

Treatment.—An effort to prevent the spread of the disease by means of ice-bags should always be first faithfully tried. As soon as fluctuation can be made out the pus should be at once evacuated. Aspiration with a small needle may prevent extension of the pus. This is a much better plan than to adopt a policy of delay, with its attendant dangers of septic phlebitis in the neighboring veins. Should the pus tend to burrow, make free counter-openings, always taking great care not to wound any of the vessels. Should the pus, when the case comes under observation, have already burrowed freely (into the supraclavicular or into the axillary region), always secure dependent drainage, by properly placed counter-openings, and dress the wound with moist, antiseptic fomentations at first.

Diffuse Cellulitis of the Neck (Non-Erysipelatous).—This is rather a peculiar affection, as it so often, especially in children, subsides without suppuration. Two such cases occurred in the writer's wards in the Montreal General Hospital during the past year. In neither case was there any suspicion of erysipelas nor did the symptoms appear severe enough for that. It would seem rather that these conditions may supervene upon some slight, often unnoticed, infection occurring in a debilitated and possibly tuberculous subject. In other cases, again,—cases which probably depend upon the nature of the infecting organism,—abscesses quickly form, and, unless they are speedily evacuated by free incisions, the tension produced by them quickly causes necrosis of the tissues, and a very serious septic condition speedily ensues.

Treatment.—Early and free incisions should always be made, with the idea of thus forestalling the possibility of abscess formation. When fluctuation can be made out, evacuate the pus without delay, inasmuch as, in its migrations in this region, it tends to spread very rapidly, and may cause erosion of some vessel, with a resulting fatal hemorrhage. There are several such cases on record and they do not reflect much credit on the non-interference plan of treatment.

B. Chronic Inflammations.

Tuberculous Inflammations.—As tuberculous inflammations are largely affections of the lymph nodes, the reader is referred to the article on this subject by Dr. Dowd (Vol. II.). With most of what is written in that article I heartily agree, but I do wish to enter a protest against the wholesale removal of inflamed lymph nodes in the cervical triangles, which many surgeons systematically practise. It is extremely doubtful whether all the infected nodes can be removed, and it is still more doubtful whether the patient would be in a safer condition were such a procedure carried out. These lymph nodes act as outposts to repel or capture the invading bacilli. Is it wise, then, to remove them all? The very common post-operative recurrence of tuberculous adenitis shows that it is either impossible to remove all the nodes that are affected, or that there has been a re-infection. In either case it is surely unwise to do an extensive dissection and to remove all the nodes which are enlarged but not actually caseous or suppurating. It is, one would think, better surgery to evacuate the pus, scrape away the necrotic tissue, and treat the surrounding structures by some means calculated to inhibit the growth of the tubercle bacilli. Then these patients should be placed in proper hygienic and climatic surroundings, and an effort made to build up their general strength, as the physician most wisely and often successfully does in tuberculous adenitis of the peribronchial lymph nodes. Personally, the writer prefers to aspirate these tuberculous abscesses, if possible, and then to fill the abscess cavity with iodoform emulsion, sealing the puncture with collodion. If the abscess has to be opened, he scrapes out the necrotic tissue, swabs the cavity with either tincture of iodine or tincture of the perchloride of iron (Barker), and then packs it with gauze soaked in ten-per-cent iodoform emulsion. Subsequent constitutional treatment will usually effect a cure; but, if it fails, one may safely assume that an extensive surgical dissection would, in a precisely similar case, be more likely to fail. What the opsonic treatment or the vaccine treatment has in store for these cases, it is perhaps too soon to say. Dr. E. M. von Eberts has lately, by this method, treated for me, at the Montreal General Hospital, a series of cases of tuberculous lymph nodes, and as a general rule they improved markedly for a time, but then did not do so well, although in one case, in particular, a gratifying permanent result was obtained, after repeated recurrences had followed previous surgical dissections. The last word has not yet been said for this treatment, and it may well be that the combination of opsonic, constitutional, and hygienic (out-door, forced feeding, rest) methods of treatment will eventually prove a great advance upon, and at any rate be of great assistance to, the surgical treatment proper, which has almost certainly, in the past, been too radical.

Syphilitic Inflammations.—Syphilitic inflammations in the neck are usually tertiary lesions, and may be either chronic ulcers or tumors due to the formation of nodes. The former present the characters of tertiary ulcers elsewhere, and a diagnosis here presents no peculiar difficulty. Tertiary nodes may develop in the sterno-mastoid or trapezius muscles and the resulting localized myositis produces contraction which simulates torticollis. The therapeutic test afforded by a course of antisyphilitic treatment rapidly clears up the diagnosis, and should always be resorted to when any doubt exists. Treatment, in both lesions, is of course constitutional, and surgical interference bespeaks, as a rule, faulty diagnosis.

Actinomycosis. Owing to its exposed position and its liability to irritation by clothing, the skin of the neck is frequently affected by the ray fungus, the presence of which gives rise to the characteristic inflammatory changes that are included under the general term of actinomycosis. Unless the case is seen early, it may be difficult to determine the primary focus, as the disease spreads rather rapidly. The jaw and cheek are both favorite primary locations. The fungus often enters by the mouth (alveolar or tonsillar actinomycosis) and thence spreads down the cellular tissue into the neck, not, as a rule, involving the lymphatics.

The clinical picture of this spreading inflammatory process is a characteristic one, and when once seen is seldom forgotten. A slow-growing, rather superficial, painless swelling develops, and is accompanied by little or no fever or constitutional disturbance. The skin over the tumor is reddish or purplish and œdematous, and in course of time a fluctuating spot develops in the centre of the area. This soon breaks down and a sticky, muco-purulent fluid is discharged, leaving an unhealthy ulcer behind, around the edges of which may be noted the small yellowish spots so characteristic of the ray fungus. (For further information in regard to this disease, the reader is referred to the appropriate article on page 458 of Vol. III.)

Diagnosis.—The diagnosis depends essentially upon the microscope, and the demonstration of the presence of the ray fungus in the inflamed tissues; but the clinical picture just given should always lead one to suspect the true nature of the disease. It is probably most difficult to differentiate these ulcers from a breaking down and infected sarcoma, as many of the symptoms will be common to both. Moreover, tertiary syphilitic ulcers may readily be mistaken for actinomycosis, because treatment by potassium iodide benefits both conditions at the outset. But experience has shown that the drug will not cure the actinomycosis, although it may inhibit its growth for a time, whereas it will continuously benefit and finally cure the syphilitic condition. However, it is an easy matter to submit a section from the ulcer to the test of the microscope, and this test will usually settle the question of diagnosis.

Prognosis.—The prognosis, of course, depends upon the diagnosis and treatment. If the disease is recognized early and treated promptly the result is usually good; in neglected cases, with extensive infection and destruction of tissue, the prognosis is bad. Cases of spontaneous cure are on record, but the tendency of the fungus is to continue to grow at the expense of its host, until finally a fatal result follows the invasion of some more deeply seated and more vital part.

Treatment.—Free evacuation of the abscess cavities and exposing at the same time the surrounding infiltrated tissue (preferably by a crucial incision, as recommended in carbuncle) should always be done as soon as a diagnosis is made. The necrotic tissue should be scraped away with a sharp spoon and the resulting cavity should be swabbed with tincture of iodine and then packed with some antiseptic gauze. This entirely does away with the more extensive cutting operations which were in vogue a few years ago, and the cosmetic and functional results are both better. The case should be carefully watched for some time afterward, and any other foci that may make their appearance should be promptly treated in the same way. Much has been written upon the administration of potassium iodide in increasing doses in this disease, and many very extravagant claims have been made for the efficiency of this remedy in even advanced cases of actinomycosis. As I have before stated, it does appear temporarily to arrest the progress of the disease; but we should hesitate to trust to this remedy entirely, though it might be administered for its inhibitory action. Rydigier (quoted by von Bergmann) advises repeated hypodermic injections of a one-per-cent solution of this drug into the affected tissues, and this may very well be done in suspected areas in the neighborhood of our incisions.

Diseases of the Lymph Nodes of the Neck.—For information on this subject consult the article by Dr. Dowd, in Vol. II.

V. TUMORS OF THE NECK.

Many of these have already been discussed in an earlier section of this article or in some other part of this work.

A. Cystic Tumors.

Congenital Serous Cysts.—For a description of these, see page 316.

Blood Cysts.—In blood cysts the smaller veins of the neck present a condition analogous to that of the lymph vessels in serous cysts. The contents of these cysts are, of course, only pure blood, not blood mixed with serous fluid, as one finds when blood escapes from a vessel into a serous cyst. These blood cysts are usually congenital, though they often remain unnoticed until their gradual increase in size draws attention to them. In some cases the conditions found warrant the belief that a cystic degeneration has taken place in a primary cavernous angioma. The cysts are sometimes of enormous size (as large as a child's head) and are occasionally situated at the side of the neck near the sterno-mastoid muscle. The tumor does not tend to infiltrate either the skin or the surrounding tissues (cf. Serous Cysts, page 316), is freely movable, fluctuates, does not pulsate, and gives no thrill or bruit. As a rule, the tumor does not disappear as a result of continuous pressure upon it, although this may happen in cases in which the cyst communicates with a large vein. The only troublesome symptoms are due to the pressure of the growth upon other structures in the neck (neuralgia, dysphagia, dyspnœa, etc.).

Diagnosis.—If one is able, by reason of the absence of symptoms peculiar to an aneurysm, to exclude this condition, then the aspirating needle may be used for the purpose of differentiating these tumors from other cystic conditions in this region.

Prognosis.—The prognosis is good, because these tumors form slowly and may never demand treatment; but, should treatment become necessary, only good results are to be looked for.

Treatment.—In infants a favorable result may often be secured by pressure upon the neck. This is best accomplished by the application of a firm compress and an elastic bandage, and the pressure should be kept up continuously. The cure is effected in much the same way as in the similar procedure for aneurysm. Injecting the cyst with sterilized tincture of iodine (1 : 5) has been carried out with success, but also with untoward results in some cases, where necrosis and sloughing followed its use. It does not seem to be good surgery deliberately to set up in a blood cyst an inflammation which you cannot, perhaps, subsequently control. In these days of aseptic surgery one should not hesitate, should the symptoms demand treatment, boldly to excise these tumors, carefully ligating all venous branches which communicate with the sac. Never operate here through a small incision; to do so is only to invite trouble through very persistent and often copious venous hemorrhage.

Sebaceous Cysts.—Sebaceous cysts may develop in the skin of the neck, especially at the nape of the neck. Their removal is easy. Puncture the cyst with a small tenotome, using local anæsthesia if desirable, then squeeze out the sebaceous contents through the puncture, and, lastly, carefully pull out the collapsed cyst wall. If this is adherent to the tissues, a small Volkmann's spoon may be required to deliver it, intact, through the punctured wound, which should then be sealed with collodion.

Cystic Enlargement of the Bursæ.—Cystic enlargement of the bursæ connected with the hyoid bone is a rare condition and very puzzling. These enlargements are very difficult to distinguish from cysts of the lower part of the ductus thyro-glossus, as well as from those cysts which develop in the thyroid gland itself. These bursal cysts do not usually grow rapidly and rarely cause trouble by themselves. Their removal, by careful dissection, is not easy, but should be done, if necessary for the relief of symptoms. (See the article on "Diseases of the Thyroid Gland," in the present volume.)

Echinococcus Cysts of the Neck.—Echinococcus cysts occur very rarely in the neck, and when present they are usually found in proximity to the large vessels at the root of the neck. von Bergmann has called attention to the periodic character of their growth—a rapid enlargement from time to time, with intervals of complete quiescence; but as a rule they slowly and continuously increase in size and may come to occupy all the supraclavicular region of one side.

Diagnosis.—The diagnosis has seldom been made before operation, though one would think that aspiration of the fluid and subsequent microscopic examination of it would render a conclusion easy. As a matter of fact, most of the cases reported have been operated upon under a mistaken diagnosis, and the true character of the growth has been established only after its removal.

Treatment.—The treatment is that of echinococcus cysts elsewhere, viz., complete excision of the sac, after careful evacuation of its contents. The results are good.

B. Vascular Tumors.

Simple Angioma.—These tumors, commonly termed "birth-marks" or "wine-marks," are usually superficial and may be either small or diffusely spread out over a considerable area. When small they may be readily removed by radium, by electrolysis, by the use of liquid air, or by ignipuncture.

Cavernous Angioma.—Cavernous angiomata are sometimes also superficial, but oftener they are situated deeper than the skin. The simple angiomata, as a result of excessive growth, irritation, or ill-advised treatment, often become cavernous. The essential difference between the two forms is that the simple angioma is a coalescence of, or a very free anastomosis between, the capillaries of the skin; whereas the cavernous angioma involves the subcutaneous vessels, generally the veins, though sometimes the vessels implicated are arterial in character (pulsating angioma), in which case the condition is difficult to distinguish from a true varix. The characteristic feature of these tumors is that they entirely disappear under continued pressure, only to reappear when such pressure is removed. When the tumor is deeply situated this symptom will be masked, and nothing but exploratory incision will clear up the diagnosis. It is not a common tumor and, as regards situation, it may be found in any part of the neck.

Treatment.—Excision is the only method when treatment of any kind is needed, which should be only when very rapid growth of the tumor or pressure symptoms indicate operation. Owing to the enlargement of all neighboring veins the operation must be carefully done and all hemorrhage controlled.

C. Solid Tumors.

Fibromata.—Fibromata are chiefly found in the posterior triangles and at the nape of the neck. These local proliferations of connective-tissue cells may be either superficial (so-called elephantiasis of the neck) or deep, and the latter are generally found connected with the nerve sheaths (neuro-fibromata), though occasionally they appear to spring from the vessel walls (angio-fibromata). They are slow-growing tumors and only secondarily cause pain. Their consistence (hard and solid) distinguishes them from lipomata, and their slow growth, with absence of enlarged superficial veins, will usually suffice to differentiate them from sarcomata.

TREATMENT.—Early excision should always be recommended, because the operation can then be done more easily, and also for the reason that these fibrous tumors, if subjected to trauma, are extremely liable to become malignant. In operating, it is often difficult to free the nerves or vessels from the tumor which appears to have grown around them; but this must be patiently done, and, when the separation has been successfully accomplished, the end results of such treatment are good.

Neuromata.—Associated with molluscum fibrosum of the face, and with pigmentation of the skin of the neck, or sometimes with hairy moles, tumors are occasionally seen growing upon the nerve trunk in the neck—real neuromata. von Bruns figures such a neuroma of the vagus nerve in the neck, associated with fibroma molluscum of the eye and temporal region. These tumors, when present, give rise to nerve-pressure symptoms. They are movable and peculiarly dense and smooth, feeling like chondromata, for which, even after removal, they are often mistaken. It is astonishing how few nervous symptoms one may have in a nerve which is completely surrounded (and, one would think, compressed) by one of these tumors. They must grow from the nerve sheath and nevertheless they do not press upon, or interfere with, the enclosed neurones.

TREATMENT.—Treatment is in every way similar to that for fibro-neuromata. The tumors must be patiently dissected out

A guarded prognosis should be given, as these growths tend to recur.

Lipomata.—Fatty tumors are often found at the back of the neck, usually attached to the fascia covering one or other complexus muscle. As they grow, their own weight often causes them to become pedunculated, though usually they spread out underneath the skin and fascia, and give the patient almost the exact appearance seen in the cervical kyphosis of Pott's disease. When they occur in the anterior triangles of the neck, they are usually pedunculated, and may hang down upon the breast, simulating some of the exaggerated conditions of goitre, so commonly seen in elderly French Canadian women. These fatty growths usually occur singly, but multiple lipomata are not uncommon, and, when found in the neck, are usually associated with a similar condition in other parts of the body, notably over the deltoid and glutei muscles. The more superficial lipomata are generally smooth and encapsulated, but the deeper varieties are often nodular, have a very thin capsule, and tend to burrow down between the deeper structures (muscles, vessels, and nerves) and thus simulate malignant conditions, but with this all-important difference—they merely *burrow*, they never *infiltrate*. But this habit of growing between, and often around, the structures in the neck, not infrequently gives rise to various and severe symptoms (pain, dyspnœa, etc.). These deeper lipomata are said to occur almost exclusively in people of middle age, and, strange to say, are more common in muscular than in fat people.

DIAGNOSIS.—The peculiar "bag-of-wool" consistence of the superficial lipomata, taken in connection with the history of the case, renders a diagnosis of this variety of tumor fairly easy, though the writer has more than once seen the mistake made of confounding them with other tumors, benign or malignant.

The deep, dissecting variety of lipoma, on the other hand, is often very difficult to diagnose from other conditions, notably "cold abscess," malignant growths (lympho-sarcoma especially), goitre, and aneurysm.

TREATMENT.—Excision should always be recommended, and preferably when the tumor is in one of its quiescent periods, for they appear to grow by periods. Thus, in the case of one of my patients, an elderly lady, a lipoma, situated at the nape of the neck, had given no trouble whatever for a period, to my certain knowledge, of fifteen years, when, in consequence of trauma, the tumor underwent a sarcomatous degeneration and speedily caused her death. In a similar case I should not now be willing to adopt such a policy of non-interference.

The removal of the superficial tumor is an easy matter and generally local anæsthesia (Barker's β-eucaine and adrenalin solution) will suffice. But fatty tumors of the deeper variety are often very difficult to remove thoroughly, and the dissection should always be done under a general anæsthetic.

Sarcomata.—Sarcomata, if primary in the neck, are generally lympho-sarcomata (Fig. 245), which are discussed in the article on "Surgical Diseases and Wounds of the Lymphatics," in Vol. II. Reference has already been made to a case of sarcoma which developed in a lipoma after it had been subjected to trauma: and one should always remember that moles and other congenital pigmented spots, which are not uncommon in the neck, may in later years undergo degenerative changes and become sarcomatous (melanotic sarcoma).

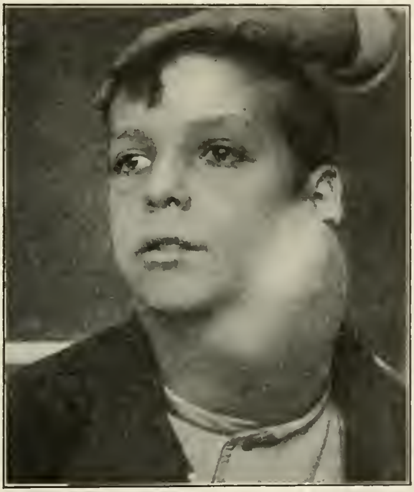

FIG. 245.—Lympho-Sarcoma of Neck, Inoperable. (Author's case.)

Carcinoma.—Carcinomata of the neck generally involve the lymph nodes, and therefore are secondary to disease elsewhere (especially the face and the mouth). On a previous page (p. 315) I have referred to branchiogenetic carcinoma, which was at one time regarded by von Langenbeck as a malignant tumor arising from the vessel-sheaths. It is quite conceivable that a lympho-sarcoma might develop in the lymphatics situated upon the carotid sheath and so give rise to the opinion that it was a primary malignant growth of the sheath itself. An interesting contribution on this subject has recently been made by Licini, from Kocher's Clinic. (*Deutsche Zeit. f. Chir.*, Dec., 1908.)

Primary carcinomata, especially epitheliomata, may arise as well in the skin of the neck as in the skin of any other part of the body. They may also form in the deeper parts of the neck, probably from some epithelial tissue enfolded in an involution cyst that has resulted from the failure of the two sides of the blastoderm, at some part of the branchial arches, to coalesce. Only thus can one explain the presence of these epithelial tumors deep down in the anterior and upper triangles of the neck, where they chiefly form, and where they are generally, and excusably, mistaken for lymph-node tumors. In Bull's edition of von Bergmann's "Surgery" (Vol. II., page 138) several very interesting cases of this kind are cited and statistics are given. It is there shown that nearly all the cases occurred in men over forty years of age, and, strange to say, nearly all the cases were on the right side of the neck.

Symptoms.—The steady growth of the tumor and the associated condition of neuralgic pain, often referred to the jaw and the ear, with loss of weight, insomnia, etc., should arouse suspicion of the presence of a carcinoma, especially if the tumor is in the neighborhood of the hyoid bone or the stylo-hyoid ligament. Involvement of the related lymph nodes speedily follows, as one would expect, and rapid infiltration and erosion of surrounding tissues take place, with a speedily fatal effect.

Prognosis.—The prognosis is extremely bad; removal is very difficult and recurrence is almost certain.

Diagnosis.—The diagnosis is difficult, and in all doubtful cases resort should be had to the microscopic examination of a small section of the tumor.

Treatment.—Early and complete excision, as soon as a diagnosis can be made, is the only thing to be recommended. In these cases excision always means an extensive dissection, for, not only must the primary focus be removed, but also all the lymph nodes of that side of the neck. The radical dissection recommended by Mr. Butlin as the second part of his operation for lingual epithelioma should give the best hope of success here. The sterno-mastoid should be boldly cut across and thrown back, thus exposing the whole anterior triangle of the neck, from which all enlarged lymph nodes are to be removed, as well as any other infiltrated structures. It may well happen that the operator, if he sees the case after the disease has made considerable advance, may deem it wise to desist, judging the infiltration to be too extensive for successful removal. In cases of this character the use of Coley's serum may afford some measure of relief. It should therefore be tried. (See Vol. III., page 454, and Vol. V., Dr. Knight's article on "Diseases of the Pharynx.") Resection of painful nerve trunks, scraping and cauterization of the growth, and other palliative measures may then be all that can be done for these patients.

SURGICAL DISEASES AND WOUNDS OF THE THYROID AND THYMUS.

By FRANCIS J. SHEPHERD, M.D., LL.D. (Edin. and Harv.), F.R.C.S.E. (Hon.), Montreal, Canada.

I. THYROID.

ANATOMY AND PHYSIOLOGY.

Anatomy.—The thyroid gland is a very vascular, dusky, brownish-red body which embraces the upper part of the trachea and extends up on each side of the thyroid cartilage. It consists of two lateral lobes united together at their lower ends by a transverse portion, the isthmus. The right lobe is usually larger than the left. Externally, it is somewhat convex and covered by a pretracheal layer of cervical fascia. It is also covered by the muscles of the front of the neck going to the hyoid bone and thyroid cartilage, and is overlapped by the sterno-mastoid muscle of each side. Its deep surface is concave and takes the impression of the trachea, cricoid, and lower part of the alæ of the thyroid cartilage, to which it is firmly attached, and follows the larynx in all its movements. Each lateral lobe on its posterior border touches the œsophagus and pharynx and overlaps the common carotid artery. Along the outer side of each lobe runs the recurrent laryngeal nerve. The isthmus crosses the trachea opposite its second, third, and fourth rings. A middle lobe often extends upward from the isthmus or adjacent portions of the lateral lobes to the hyoid bone; this is normally represented by a strand of fibrous or muscular tissue.

The weight of a normal thyroid is about one ounce (30 to 40 grammes); the length of each lobe is two inches, the breadth one inch and a quarter. The organ varies greatly in size, however, being relatively larger in the female and child than in the adult male. The isthmus may be absent or fused to one or other lobe.

Accessory Thyroids.—Accessory thyroids, consisting of small detached portions of thyroid tissue, are frequently found in front of and above the hyoid bone, or laterally near the great cornu of the thyroid cartilage.

Vascular Supply.—The thyroid is supplied by four large arteries, viz., two superior thyroid arteries, from the external carotid, and two inferior, from the thyroid axis of the subclavian of each side. Occasionally (five per cent) a middle thyroid artery (thyroidea ima) is given off from the innominate artery. The veins are very large and form on the surface of the body plexuses, from which proceed the superior, middle, and inferior thyroid veins, the two first named emptying into the internal jugular and the latter into the transverse innominate vein. As a rule, the veins of each side unite to form one or more large vessels which course down the trachea to empty into the transverse innominate vein.

Nerves.—The nerves are derived from the middle and inferior ganglia of the sympathetic and accompany the blood-vessels.

Structure.—The normal thyroid consists of vast numbers of vesicles or alveoli which are closed and are of various shapes and sizes. They are held together by areolar tissue. The vesicles contain a glairy yellow fluid (colloid matter) which escapes on the gland being cut, and are lined by cubical or columnar epithelial cells. The gland is invested by a thin transparent layer of dense connective tissue which dips down and separates the gland into lobules of various shapes and sizes. Along these septa proceed the blood-vessels, while the capillaries ramify upon the outer surface of the vesicles.

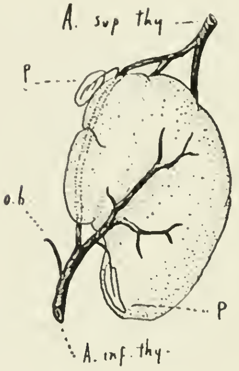

Fig. 246.

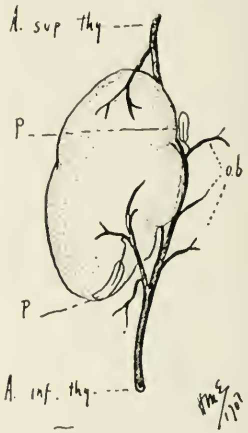

Fig. 247.

Figs. 246 and 247.—The Parathyroid Glandules and their Arterial Supply. (After Halsted and Evans, in *Annals of Surgery*, Oct., 1907.)

Fig. 246.—The Lower Parathyroid Artery arises from the Lateral Branch of the Inferior Thyroid Artery; the upper parathyroid artery arises from the anastomosing ramus between the superior and inferior thyroid arteries.

Fig. 247.—The Lower Little Artery comes from one of the Lateral Glandular Branches of the Inferior Thyroid, while the upper one is a branch of the uppermost œsophageal branch.

According to Bloodgood, "the thyroid, in young embryonic life, is composed of acini lined by epithelial cells of a rather characteristic type, and the epithelial vesicle contains no colloid matter. Many of the acini are filled solidly with cells. The stroma is rather scanty, and quite vascular. Tumors which resemble the fœtal thyroid gland in its histology have been called fœtal adenomata. . . . Later in embryonic life colloid material appears in the epithelial acini, and, with their distention with this material, the acini become lined with a single layer of cells."

Physiology.—Our knowledge of the physiology of the thyroid has been derived from those cases in which the gland has been designedly removed from man or animals, or where thyroid extract has been administered. In the one case there is deficiency of thyroid secretion, and in the other an excess. It is now fairly well established that the complete removal of the thyroid alone produces myxœdema, and, if all the parathyroids are also removed, tetany usually ensues. It was formerly thought that tetany frequently followed complete removal of the thyroid, and this because these experiments were performed on carnivora in whom the parathyroids are closely associated with the thyroid and consequently were always removed with the thyroid, but in herbivora complete removal of the thyroid was not followed by tetany simply because the parathyroids, not being placed in such close relation to the thyroid, were left behind, and hence no symptoms of tetany followed. (Figs. 246–252.)

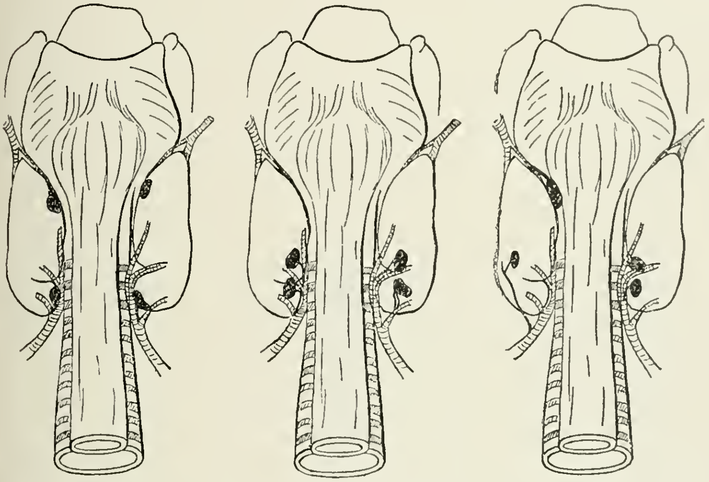

Fig. 248. Fig. 249. Fig. 250.

Figs. 248–250.—Diagrams Showing the Different Positions Occupied, in Different Cases, by the Parathyroid Glands. (MacCallum, in *British Medical Journal.*)

Fig. 248.—Organs of the Neck as seen from behind. Four parathyroids—represented as four black oval bodies—are seen in the positions which they commonly occupy.

Fig. 249.—The Two Upper Parathyroid Glands lie close to the Lower Pair, which are in their Usual Position.

Fig. 250.—The Left Upper and the Right Lower Glands are in their most Typical Position. The right upper gland lies in the region of the inferior thyroid artery; the left lower gland, supplied by a long arterial branch, is embedded in the posterior surface of the thyroid near its outer margin.

However, in a certain proportion of animals, where both thyroid and parathyroids are completely removed, no symptoms whatever result, and this may also be said of man, for in many cases of apparently complete removal of the thyroid, with ligature of the four arteries, nothing happens. This may be due to the fact that some of the parathyroids are placed at some distance from the thyroid and that there are supernumerary thyroids in the region of the hyoid bone, close to the great cornua of the thyroid cartilage.

David Forsyth, of London, holds that it is quite impossible to know if we have removed all the parathyroids, as they vary much in number and position. They may number from one to eight, and may be buried in one of the thyroid lobes, bound up in the capsule of a lymph node or an accessory thyroid; he says they may be of very small size and that there are no certain means of identifying a parathyroid except by the microscope.

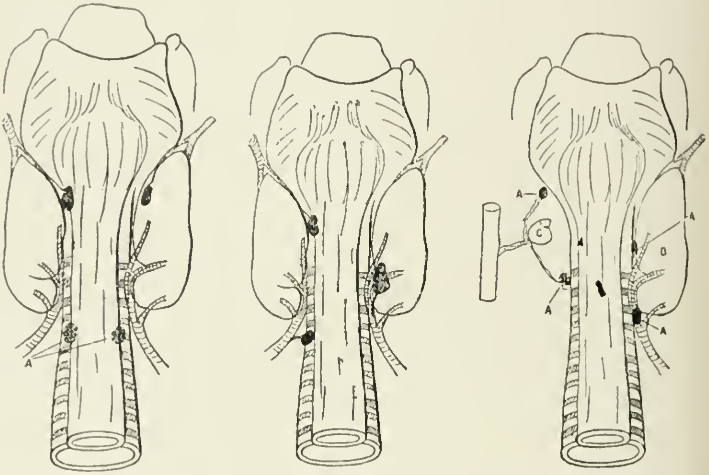

Fig. 251. Fig. 252. Fig. 253.

Figs. 251-253.—Additional Diagrams Showing the Different Positions Occupied by the Parathyroid Glands. (MacCullum, in *British Medical Journal.*)

Fig. 251.—The Two Upper Parathyroid Glands are in the Common Position. The two lower glands (A) lie on the anterior surface of the trachea.

Fig. 252.—On the Left Side there are Two Parathyroid Glands, while on the Right only One Large Gland is to be found.

Fig. 253.—On the Right Side the Condition of the Parts (B) is Practically Normal; on the left side, however, the thyroid lobe (C) is almost completely atrophied, but the parathyroids (A, A) are found about in their usual positions.

In cases where the thyroid has been removed or the thyroid secretion has been much diminished, a certain set of symptoms follow which are known by the name of myxœdema—cachexia strumipriva, or cretinism.

The first changes, in this condition, manifest themselves in the nutrition. All metabolic changes are incomplete, the connective tissues remain in the embryonic condition. The patient's hair falls out; there is little expression owing to the obliteration of the lines of the face; the skin becomes swollen and inelastic, dry, and harsh; the weight of the body increases; the features become coarse, the nose and lips being larger than usual; etc. The nervous system is affected; there are twitchings, tremors, and spasms in thyroidectomized animals.

The pulse is slow, and patients want to sleep a good deal. In operating it is well to leave some thyroid behind, to prevent the condition described above.

Where there is excess of thyroid the symptoms are quite different: metabolism is increased, and in the urine there are great quantities of urea, phosphates, and chlorides. The patient gets thinner; the nervous symptoms are indicated by tachycardia, and by the fact that the patient is excitable, irritable, and sleeps less. If too much thyroid extract has been given internally there are often acute symptoms, such as headache, nausea, and vomiting.

There is some close relation between the sexual functions in the female and the thyroid, for the thyroid enlarges during menstruation and pregnancy and atrophies after the menopause. In old age there is marked atrophy of the thyroid and it has been suggested that this has some influence on senility. It is said that pregnant animals who have but little thyroid develop an insidious kidney disease which results in convulsions and in coma, not relieved by thyroidin. Pregnant animals need a larger thyroid than those not pregnant. (Lange.) Blum found in the dog that thyroidectomy was followed by albuminuria and sometimes by hæmaturia. The writer has found that in patients who have died after operation for Graves' disease, the genital organs are undeveloped, especially the breasts and uterus, and that the thymus is always enlarged.

According to Moussu the function of the thyroid and parathyroids is quite different. Suppression of thyroid functions only produces chronic symptoms, such as myxœdema, while removal of the parathyroids induces acute symptoms —tetany, etc. Welch says: "Removal of all four parathyroids in the cat causes a rapidly fatal issue, even if the thyroid remains uninjured: removal of three parathyroids does not lead to death. All the thyroid and some parathyroids may lead to death if only one parathyroid remains." Removal of the thyroid in young animals arrests growth, both physical and mental, and in human beings who are cretins, the development of the genital organs is arrested and a condition of infantilism prevails. (See also Addenda on p. 400.)

By transplanting a portion of the thyroid to other parts of the body serious results of excision may be obviated. A certain amount of the gland is necessary to produce proper metabolism; the amount necessary varies greatly with different individuals. The thyroid stimulates the elimination of nitrogen. Baumann has proved that pure iodine is present in the thyroid as an organic combination, iodothyrin, and this preparation can now be obtained mixed with milk sugar and is given instead of thyroid gland tissue when such treatment is indicated.

The function of the thyroid, however, is still a much disputed question: some look upon it as having an antitoxic effect. Blum found that ninety-six per cent of the dogs from which he had removed the thyroid died when fed on meat, but only sixty per cent died when they were fed on milk. Dogs which were going on well with a milk diet, when fed on meat developed symptoms of athyreosis, and hence it is supposed that substances formed by meat in the gastro-intestinal tract are neutralized by the normal thyroid. On the other hand, Oswald says that young calves have no iodine in their thyroids, and hence cow's milk contains thyroidin, which would explain the different effects of a meat and a milk diet. Some hold that the thyroid is a secretory organ which is necessary for the metabolism and for the nourishment of the system. (Richardson.)

DISEASES.

Goitre. —SYNONYMS: French, Goître; German, Kropf; Italian, Gozzo; English, Wen or Derbyshire Neck, Bronchocele.

Although the term "goitre" was first applied to the enlargement of any organ, of late years its use has been confined to enlargement of the thyroid. Goitre or bronchocele occurs endemically, epidemically, and as a sporadic disease. It is a well-known fact that goitre occurs more frequently in some regions than in others, and it is always present in some places, even the animals being affected. When it is endemic then cretinism is sure to exist. It is endemic in certain places in nearly every country in the world. In North America it is very common in French Canada, Hudson's Bay, the New England States, and Mexico.

It is now the commonly received opinion that the drinking water is the cause of goitre. Waters from definite geological formations cause it, according to some (Bircher), and micro-organisms introduced with the drinking water, according to others (Luecke). Drinking from certain wells (Kropfbrunnen), in some districts in Germany, is known to produce goitre, and to avoid military service it is the habit of men to drink constantly from these wells and acquire a goitre. In districts where goitre abounds instances are known where, when the water supply was changed and was obtained from a non-goitrous district, the percentage of goitrous children fell from fifty-nine to eleven per cent in ten years.

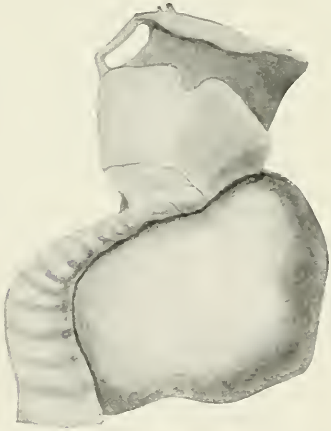

FIG. 254.—Lateral Displacement of the Trachea by a Large Goitre. (From Demme.)

Lustig and Carle experimented with a horse and produced goitre by giving it water from an infected well; then later, when it was given ordinary water, the lobe returned to its normal size.

Bacteriological examination of water has, so far, not been rich in results. Goitre is no doubt produced by a specific organism, but this organism has yet to be found. No doubt, some individuals are more disposed to give it lodgment and encouragement than are others.

Most goitres are acquired, though some are congenital, but only in localities where the disease is endemic; in these cases the thymus is also enlarged at the same time.

Goitre is far more common in females than in males, and it usually first appears about the period of puberty. When a number of cases occur in a region where goitre is endemic, the disease is said to be *epidemic*. Sporadic goitre is quite different from the endemic form; it occurs chiefly in young chlorotic girls and may have something to do with menstruation. Goitre tends to enlarge during menstruation and pregnancy, and it is said that sexual excitement produces temporary enlargement of the thyroid; it is also claimed that defloration is always accompanied by enlargement of the thyroid (Pratt) and that a woman's neck is always larger immediately after marriage; this enlargement being held by some Eastern nations to be a proof of virginity.

During febrile diseases goitre may diminish in size, and Luecke states that, where there is a marked diminution in the size of the goitre, with emaciation, then iodine has been used secretly in large quantities. Goitre may increase suddenly, or grow slowly, or remain stationary, and may even diminish and disappear.

The enlargement of the thyroid may be bilateral, unilateral, median, or limited to a portion of the gland. In some cases the enlargement, though quite imperceptible, owing to the fact that it is confined behind the sternum, may cause great distress; in other cases the tumor is quite free and is called a "wandering goitre." It may extend as high as the submaxillary region or as low as the arch of the aorta. The gland usually moves with respiration. Goitre may grow to immense size, being in some cases larger than the patient's head, and may hang down well over the chest. Where one lobe alone is affected it is usually the right.

DIAGNOSIS, AND THE EFFECTS PRODUCED BY PRESSURE OF AN ENLARGED THYROID.—The diagnosis of goitre is not usually a matter of great difficulty, and it is only in anomalous cases that any doubt may exist. The facts that the tumor is situated in front of the trachea and on the sides of the larynx, and that on swallowing it moves with the larynx, are important and significant; yet the writer has known of cases in which the swelling was mistaken for sarcoma, aneurysm, etc. The usual trouble caused by a growing goitre, other than that existing in Graves' or Basedow's disease, is, first, breathlessness on exertion, due possibly to pressure on the trachea; and this supposition can be confirmed or contradicted by laryngoscopic examination. The trachea may be compressed laterally (Fig. 254) or antero-posteriorly; if bilaterally, the trachea assumes a knife-like shape (Fig. 255); if antero-posteriorly, it appears of ribbon shape. In other cases there may be a circular constriction of the trachea (Figs. 256 and 257); in such a case the gland would of course surround the trachea. The trachea may be pushed to one side or the other, carrying the larynx with it.

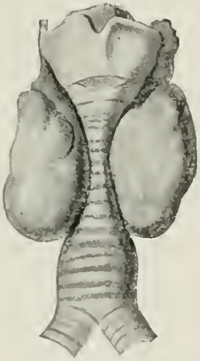

FIG. 255.—Bilateral Compression of the Trachea. (From Demme.)

Again, the trachea may undergo degeneration and softening, and Rose declares that kinking of a softened trachea may be the cause of sudden death.

In carcinoma of the thyroid there may be infiltration, not only of the trachea but also of the œsophagus. Pressure on the œsophagus is not uncommon, and causes difficulty in swallowing, but is not as dangerous as when the goitre presses on the trachea. In some cases the tumor pushes itself out between the œsophagus and the trachea and thus causes a displacement of the gullet. In one of the writer's cases—that of an immense left-sided goitre in a woman aged sixty-two—the only symptom was difficulty in swallowing, and at the operation it was found that the œsophagus was pushed outward, passing downward to the left of the tumor, and was much elongated and stretched in the process. This was a case of retro-tracheal goitre. (Figs. 260 and 265.)

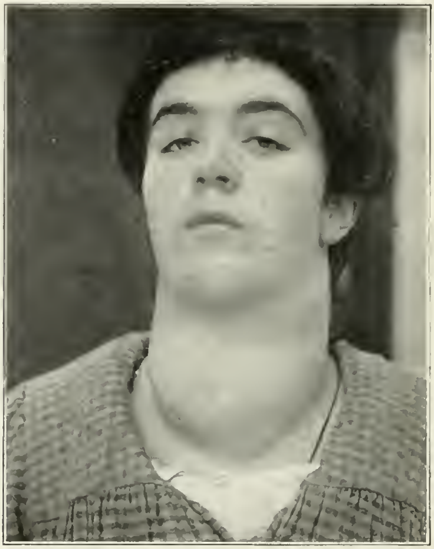

FIG. 256.—Case of Circular Goitre. (Cystico-colloid goitre, with struma Gravesiana colloides.) (Montreal General Hospital.) The patient, aged sixteen, manifested tachycardia and nervousness, with dyspnœa; there was no exophthalmos. Removal of the entire gland; recovery.

Constriction of the gullet is most likely to occur in cases of inflammation of the goitre or in malignant disease of the gland. Displacement of the arteries is very common, and they may be much enlarged. The veins are, as a rule, much distended, owing to obstruction to the flow of venous blood to the heart. (Figs. 258 and 259.) The goitre may affect the recurrent laryngeal nerves, causing paresis by pressure. If the pressure be long continued, atrophy may take place. The nerve may, according to Woelfler, become in some cases adherent to the capsule and much thickened.

Symptoms.—A goitre may exist in an individual and yet be unnoticed until the patient's attention is drawn to it by the fact that the collar band is getting too tight or by noticing a fulness in the neck while looking at herself in the glass. Many patients have had their attention drawn to the increased size of the neck by their friends.

Symptoms Resulting from Pressure on the Trachea.—When going upstairs, or walking quickly, the patient notices a great shortness of breath, and when the slightest cold is contracted there is difficulty in breathing. Again, whenever any exertion, such as carrying weights, rapid walking, stooping, etc., is made, stridor is developed. With inspiration there often is whistling. Some patients often have severe attacks of suffocation, while others, even with very large goitres, manifest very few symptoms, not even stridor to any marked degree. Sudden attacks of dyspnœa may occur from very simple causes, such as swallowing food the wrong way, a slight catarrh, etc. Such a cause may produce œdema of the glottis and thus suddenly terminate the life of the patient.

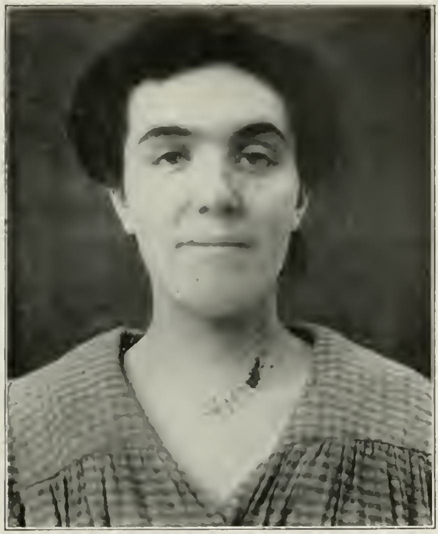

Fig. 257.—Photograph of the Same Patient (Fig. 256), a Week after the Operation. (Montreal General Hospital.)

Symptoms Resulting from Pressure on the Nerves.—The dyspnœa may be caused by paralysis of the recurrent laryngeal nerve, and may come on quite suddenly from slight increase of the tumor due to hemorrhage into its substance or to sudden congestion. The abductor muscles are first paralyzed—strumic asthma is the name given to such cases.

On laryngoscopic examination it is quite common to find paralysis of one vocal cord; rarely are both paralyzed. When one cord is paralyzed it is compensated for by the cord of the other side moving over to the affected side, and very little change will be noticed in the voice, except that the patient tires easily on talking. When both cords are paralyzed the patient is voiceless and is comfortable only when perfectly quiet.

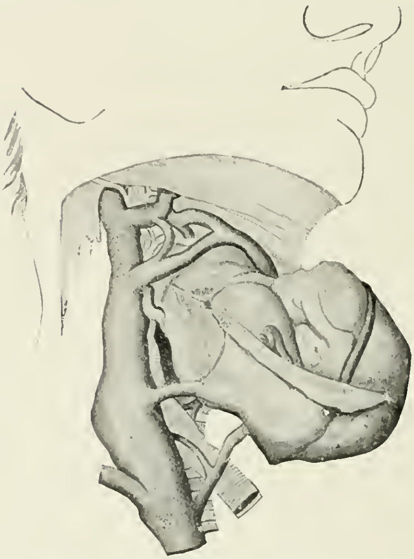

FIG. 258.—Veins in Connection with Enlarged Thyroid. (From Woelfler.)

Paralysis of the abductor muscles is a most serious condition and causes severe attacks of dyspnœa. Expiration is quiet, but inspiration is difficult owing to the aspiration of the cords. In one case operated on by the writer, where there was paralysis of the left cord, a portion of the right nerve was accidentally seized during a spurt of bleeding and immediately inspiration was whistling and very difficult, while expiration was easy. Tracheotomy had to be performed. The tube was removed in a week, and at the end of two weeks the patient was discharged with as good a voice as before operation. It is not uncommon, in large goitres, to see the cords acting sluggishly, and in other cases a more pronounced degree of paresis, which disappears on removal of the tumor. When one cord is paralyzed it is usually the one opposite to the side on which the thyroid tumor is largest. If the paralysis is due to pressure only and no atrophy of the nerve has taken place, the function of the nerve is completely or partially restored after operation. In some cases the pressure produces merely irritation of the nerve; this is the cause of spasmodic fits of coughing, especially when the patient undertakes any unusual exertion.

The vagus is rarely affected, and when this occurs there is said to be slowing of respiration. (Bruberger, Pinner.) The sympathetic is occasionally involved. Irritation causes dilatation of the pupil and paralysis contraction and narrowing of the palpebral slit. The writer has never seen the hypoglossal affected, though cases are reported.

The severest symptoms are not always connected with the largest goitres.

Some very large pendulous goitres give no trouble, except from their size and weight, whilst others, quite small, situated deeply beneath the sternum or behind the pharynx, cause much trouble. Circular goitres also, as well as the retrosternal variety, even those which are quite small, are, when suddenly enlarged by hemorrhage or by inflammation, the cause of severe symptoms. Woelfler gives the symptoms as follows: pain on swallowing, arrest of solid and semisolid food so that only liquids can be taken, and, in some cases, the arrest of swallowing altogether.

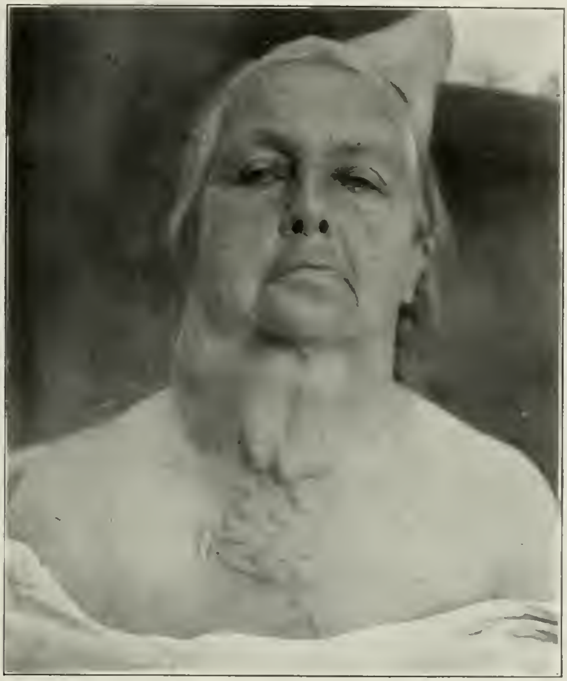

Fig. 259.—Photograph of a Patient in whom the Goitre Caused Venous Obstruction. (Original.)

Circulatory Disturbances.—Circulatory disturbances are not uncommon. They may be due to obstructed breathing or to direct pressure on the blood-vessels. Dilatation of the veins of the neck over the tumor, and even on the chest below the tumor, is seen. These veins may become tortuous and varicose, and may reach a large size.

In many cases simple goitre may develop into Graves' or Basedow's disease, for in many cases there are all the symptoms of this disease except the exophthalmos. (Figs. 261 and 262.) Tachycardia is a very common symptom, and so also are dyspnœa, attacks of palpitation and breathlessness, tremor, and emaciation. In fact, any simple goitre may eventually develop into Graves' disease. Tachycardia may be produced by difficulties in breathing. Obstruction to respiration causes increased pressure on the veins, especially the jugular, and this is followed first by dilatation of the right auricle and then by dilatation and hypertrophy of the right ventricle. (Rose, Woelfler.) As the obstruction to the flow of blood increases, cyanosis becomes more marked. This may be produced by pressure on the veins or the cardiac nerves, and may be followed by œdema of the mouth and even of the upper extremity. Palpitation, irregular pulse, and fainting attacks may ensue, and the end may come suddenly.

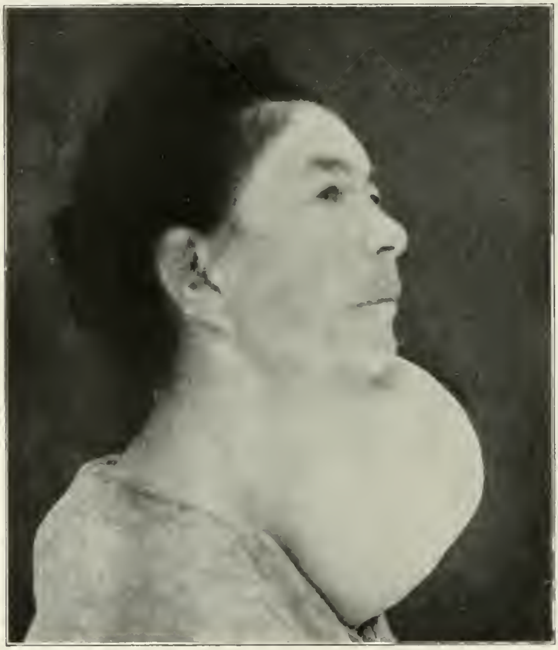

Fig. 260.—Large Cystico-Colloid Growth of the Left Lobe of the Thyroid, Growing Between the Trachea and the Œsophagus, the Latter being External to the Tumor. (Original.)

The consistence of goitre varies greatly in the same case. In the adenomatous form the goitre is usually soft and doughy. Some goitres are very hard, and if a cyst forming a part of the tumor be very full of fluid it may convey the impression that the goitre is of the hard variety. Old goitres may be very hard and may have a calcareous shell about them.

Complications.—There may be severe hemorrhages into cysts. The writer has known this to occur as the result of straining and vomiting, or of sea-sickness. The cysts themselves may rupture and blood may flow into neighboring parts. Rupture of a cyst into the trachea or larynx has led to a fatal termination from suffocation. Inflammation of the thyroid is an accident which may occur. *Strumitis* is inflammation of an already enlarged gland, while inflammation of the normal thyroid is called *thyroiditis.* These inflammations may occur as the result of typhoid fever. Of course, in general infection the thyroid may be affected like any other organ. Inflammation of the gland may end in resolution, abscess, or gangrene. Abscess is the usual result, and early opening almost invariably terminates favorably.

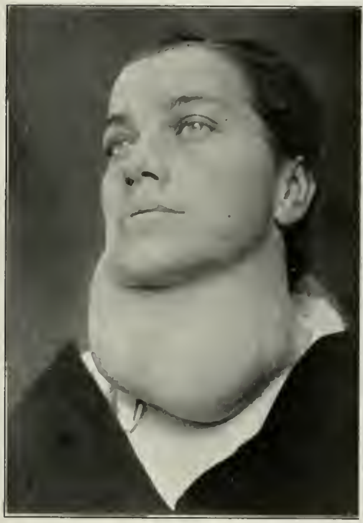

Fig. 261.

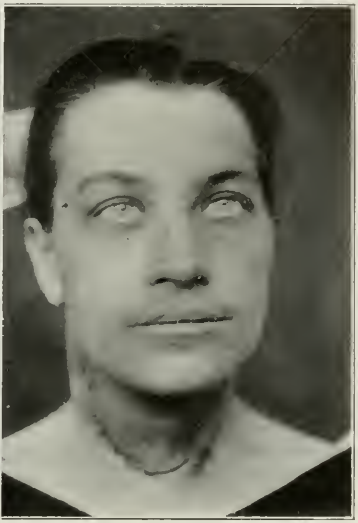

Fig. 262.

Fig. 261.—Very Large Cystico-Colloid Goitre in which Symptoms of Graves' Disease were Commencing. (Original.)

Fig. 262.—Photograph of the Same Patient (Fig. 261), Showing Scar of the Incision Employed in Removing the Tumor. (Original.)

Abnormal Goitres.—A goitre may be abnormally movable, rising and falling noticeably during respiration, and sometimes being much above, at other times below, the episternal notch. These are called "floating goitres," "diver goitres," etc. Kocher has named this condition "thyroptosis."

Circular goitres are those in which the transverse measurement is greater than the vertical. The two upper horns may project upward and backward, so that they almost meet and surround the trachea and œsophagus. In these cases difficulty in swallowing, as well as difficulty in speaking, is common.

Should the cornua grow downward as well as upward, then we have a tubular goitre.

A goitre may be without an isthmus, or may consist of one lobe only.

A pyramidal process, extending from the isthmus or from one lobe to the hyoid bone, is not uncommon. The writer has seen one case where the gland surrounded the trachea and œsophagus, passing between the latter and the vertebral column. In this case the arteries were anomalous, and on the left side only was there an inferior thyroid. There were accessory thyroid glands above each superior cornu.

Accessory Thyroids.—Accessory thyroids are not uncommon. They consist of small detached portions of gland usually in the embryonic stage, and may be found anywhere from the base of the tongue to the arch of the aorta. They may, or may not, be connected with the main gland by bands of fibrous tissue.

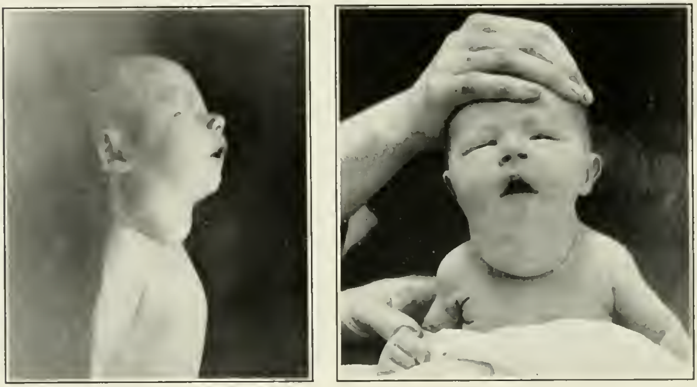

Fig. 263. Fig. 264.

Figs. 266 and 264.—Case of Congenital Goitre; side and front views. (Author's case.)

Inferior accessory thyroids, which are intrathoracic, always develop from the isthmus. Retroclavicular and posterior accessory thyroids usually develop from the lateral lobes. The intrathoracic goitres may be of large size and, on the side where one of these accessory goitres exists, the normal lateral lobe may be absent. No doubt, accessory thyroids in the line of the thyro-glossal duct are derived from that source.

Many cases of thyroid tumors at the base of the tongue are reported; they are derived from the pyramidal process or the lingual duct. Sometimes they are of large size and their removal is very difficult; hemorrhage is often profuse. If pedunculated, these tumors may be removed with a cautery. The diagnosis of these growths is very obscure and they may be mistaken for gummata. E. Paton, of London, reports a case of accessory thyroid gland in the floor of the mouth.

Thyroid tissue has been found within the trachea at its junction with the larynx—a very rare condition. A goitre has been occasionally found between the œsophagus and the vertebral column. Difficulty in swallowing is a prominent symptom in such cases. Beneath the skin of the chest have been found cysts which communicate with cystic goitres.

The most common situation, however, for accessory thyroids, is in the neighborhood of the greater cornua of the hyoid bone. When the thyroid is goitrous these accessory glands are very likely to be so also, and occasionally they may enlarge separately and produce tumors of considerable size.

Congenital Goitre. — Congenital goitre is not uncommon in goitrous districts and occurs sporadically in other places. It may be an obstacle to normal labor by causing extension of the head. Pressure on the tumor during parturition has caused death from asphyxia, and cases have been reported where the tumor was large enough to render labor practically impossible.

Demme (Gerhard's "Handbuch der Kinderkrankheiten," Bd. III., 1879) has reported 642 cases of goitre in infants and children, and 37 of these occurred before the age of one month and 59 at ages varying from two to twelve months. In 53 cases the goitre was congenital. It is more frequent in females, and sometimes is located on one side only, usually the right.

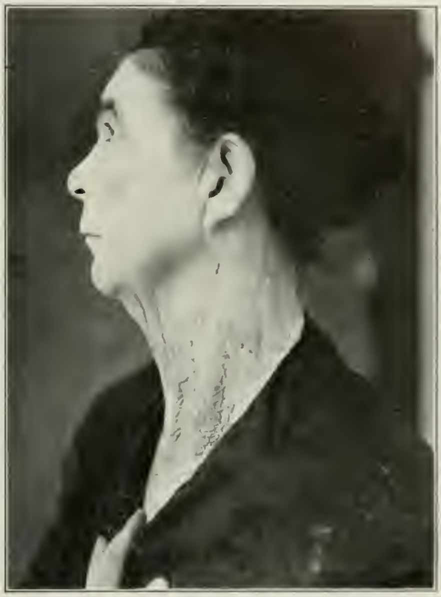

Fig. 265.—Photograph of the Patient Shown in Fig. 260 Ten Days after Operation. (Original.)

Congenital goitre may be of all the usual forms, but generally consists of a uniform enlargement of the whole gland, the right lobe usually being larger than the left. The swelling may extend from the lower jaw to the sternum. A few days after birth the tumor decreases spontaneously and rarely remains as a permanent enlargement. The mother may have enlargement of the thyroid, as in the case illustrated. (Figs. 263 and 264.)

This case, for the notes of which I am indebted to Dr. Little, of the Montreal Maternity Hospital, occurred in a male infant, and was the cause of difficult labor. For some days after birth the tumor seemed to increase, and at one time tracheotomy was contemplated. However, after a week the swelling began to subside, the left side more rapidly than the right, and at the end of fourteen days the right lobe had diminished by half and the left was no larger than a bean. The size of the goitre at birth was: right lobe 3.5 cm. broad and 5 cm. long; left, 3.25 cm. broad and 4 cm. long.

From the rapidity with which the tumor diminishes in size and disappears, it is supposed that the swelling is due simply to an acute hyperæmia, but it is said that in some cases there is also hyperplasia, with increase in the number and enlargement of the follicles, and with cyst formation. The thymus in these cases is also enlarged.

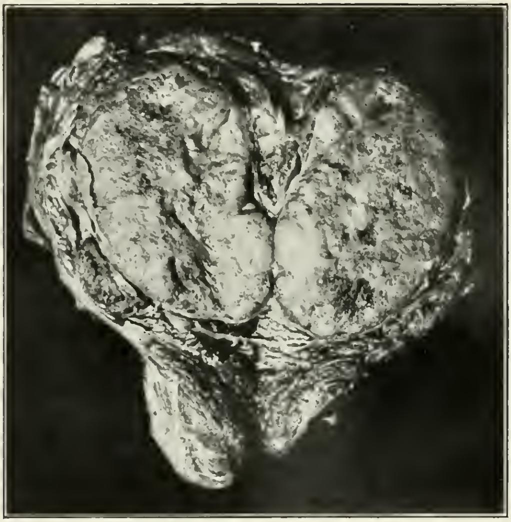

Fig. 266.—Encysted Adenoma of the Thyroid. (Original.)

Classification of Goitres.—It is very difficult to classify the various forms of benign goitres. The following classification is one that is clinically useful:—

1. Adenomata, (*a*) simple, (*b*) fœtal.
2. Cystico-colloid goitres.
3. Cystic goitres.
4. Hyperplastic goitres.
5. Vascular goitres.

1. *Adenomata.*—(*a*) Simple adenomata are the most common; structurally they represent merely an exaggeration of the normal thyroid. The vesicles filled with colloid are larger and the epithelium is flat or cuboidal. Adenomata are more often confined to one lobe, usually the right, but sometimes the whole gland is involved. The adenoma may again form a distinct tumor which is surrounded by a capsule. These tumors may be multiple.

(*b*) Fœtal adenomata possess a structure like that of a fœtal thyroid. There are few vesicles and little colloid. The cells fill up the vesicles and are columnar in character. These adenomata are usually provided with a capsule and are quite distinct from the rest of the thyroid.

2. *Cystico-colloid Goitres.*—This form may be regarded as a degeneration of the foregoing. A cyst is formed in an adenoma by a sudden increase of the colloid in one or more vesicles. The pressure pushes aside or ruptures adjoining vesicles and cysts are the result. The tumor is formed of colloid growths with cysts. (Fig. 260.)

3. *Cystic Goitres.*—Sometimes a cyst attains a large size and takes up the whole tumor. (Figs. 267 and 270.) Sometimes there are several cysts. Their contents may be clear or tinged with blood. When a cyst suddenly enlarges this is probably due to a hemorrhage, as a result of which the sac becomes filled with blood; in fact, it sometimes happens that the cyst is the product of a hemorrhage. These goitres, as a rule, are not vascular. The cyst wall may become quite fibrous in character, and, if it lasts many years, lime salts are deposited in it and large calcareous plates may be formed. The writer has occasionally seen the whole cyst wall converted into a single calcareous mass.

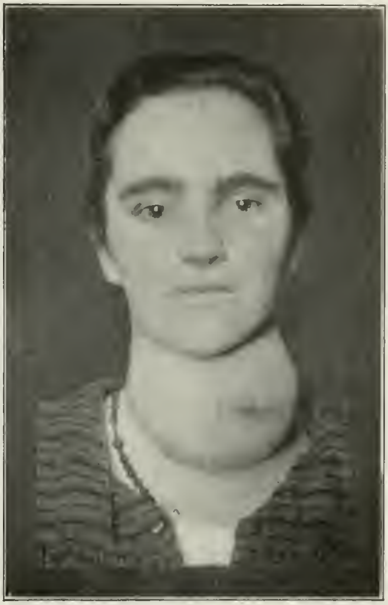

Fig. 267.—Simple Cystic Tumor of the Thyroid. (Original.)

4. *Hyperplastic Goitres.*—This form is seen in cases of true Graves' disease. There is a great development of epithelium, which is always of the cylindrical variety. (Fig. 271.) This epithelium sometimes forms papillary excrescences in the lumen of the vesicles, which latter do not contain colloid material, but rather a clear fluid. (Kocher.) The gland is very vascular and there is great capillary hyperæmia. (Sections of normal infantile and adult thyroids are shown in Figs. 268 and 269.)

5. *Vascular Goitres.*—There is no true form of vascular tumor of the thyroid. In the cases to which the term "vascular goitres" is applied, there is an hypertrophy of all the blood-vessels; the whole gland is swollen and there are a thrill and a systolic bruit. The tumor is soft. It is really an early stage of Graves' disease, for there are tachycardia and tremor and often ocular symptoms.

Kocher says these are the cases which can be treated successfully by the internal use of iodine or phosphates, and in which a radical cure by operation is particularly favorable.

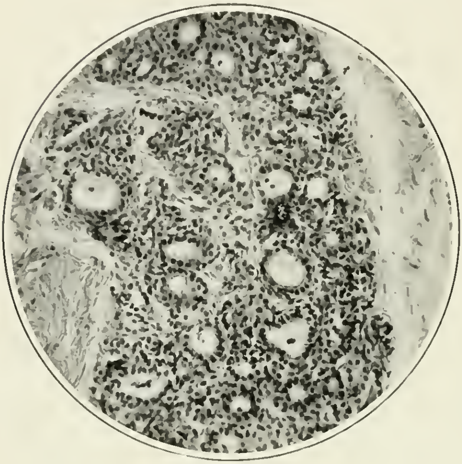

FIG. 268.—Section of Normal Infantile Thyroid, magnified about 1,000 diameters. (Original.)

Acute Inflammation of the Thyroid.—This is not a very common affection. The normal thyroid seems to have considerable power of resisting infection. Inflammation is much more frequent in goitrous cases. Contusions, wounds, and congestion due to pregnancy, etc., may predispose to such inflammation. In many of the fevers and infective affections the gland may become inflamed; in fact, whenever there is a general infection metastases may occur in the thyroid. When a metastatic inflammation occurs in a previously normal thyroid this process, as already stated (page 364), is called *thyroiditis;* and when it occurs in a goitre, *strumitis.* This metastasis may occur in typhoid, scarlet fever, puerperal fever, pyæmia, pneumonia, variola, diphtheria, malaria, and also in acute articular rheumatism. The Bacillus coli even has been found in abscess of the thyroid.

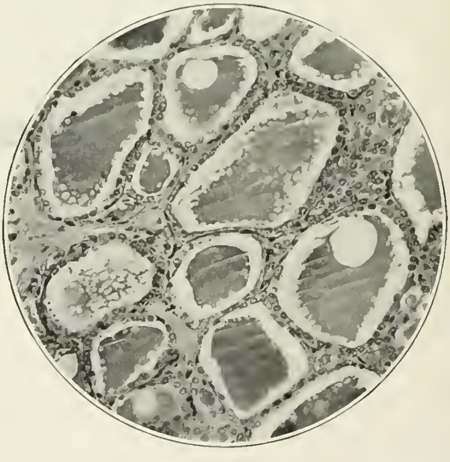

FIG. 269.—Section of Normal Adult Thyroid, magnified about 1,000 diameters. (Original.)

The symptoms are the usual ones of inflammation—namely, redness, heat, swelling, and pain. These are often very acute, and the rapidity of the swelling may seriously interfere with respiration and deglutition. The inflammation may terminate in resolution, in abscess, or even in gangrene. There may in some cases be great infiltration, reaching as high as the floor of the mouth. In some cases, again, pus has perforated the trachea and has caused death by suffocation. The œsophagus has also been perforated. The gangrenous cases are uncommon, but when they exist the symptoms of sepsis are very severe.

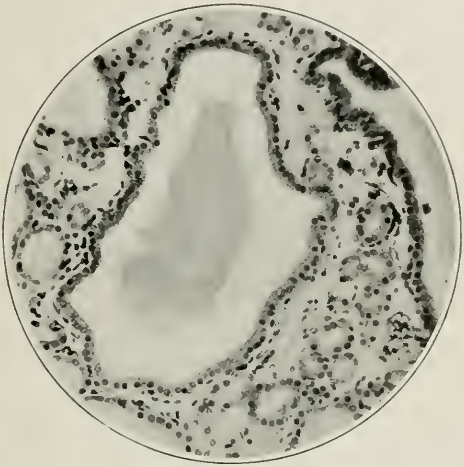

FIG. 270.—Section of a Cystic Thyroid, magnified about 1,000 diameters. (Original.)

In acute inflammation free incision, followed by packing of the wound, is demanded. If pus is present it should always be evacuated. Both Kocher and Eiselsberg report the occurrence of fatal tetany in cases of suppuration of the thyroid gland. In Kocher's case the tetany developed after half a suppurating thyroid had been removed. In these cases, no doubt, there was destruction of the parathyroids. Cases of myxœdema and cretinism have been reported as a result of destructive inflammation of the thyroid.

Infective Inflammations of the Thyroid.—*Tuberculosis.*—Tuberculosis of the thyroid occurs most frequently in generalized miliary tuberculosis. Chiari found miliary tubercles in the thyroid in seven per cent of the cases of general miliary tuberculosis. Tuberculous nodules may develop in the thyroid and produce symptoms of pressure. von Bruns reports a case of paralysis of the recurrent laryngeal nerve from this cause. Sometimes these masses may be mistaken for true goitre.

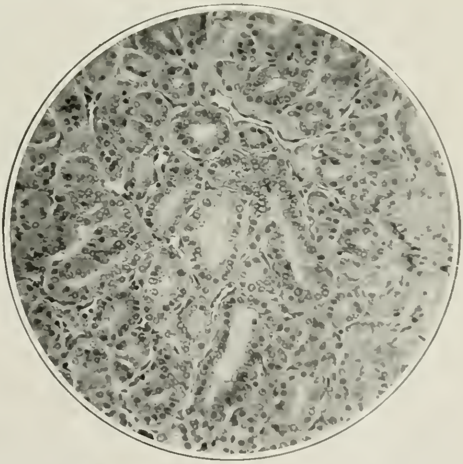

FIG. 271.—Section of a Hyperplastic Goitre, magnified about 1,000 diameters. (Original.)

Roger and Garnier say that sclerotic changes of the thyroid are common in chronic phthisis.

Syphilis. In the early stages of syphilis the thyroid gland may markedly increase in size in sympathy with the other glands, but it rarely remains permanently enlarged. Gummatous deposits are not common and occur chiefly in children. In adults they may grow so rapidly that the suspicion of malignancy may be excited, but treatment by potassium iodide quickly clears up the diagnosis. The whole gland may be involved and cause myxœdema, which yields rapidly to antisyphilitic treatment.

Actinomycosis.—Actinomycosis may occur through metastasis or through extension by way of the cervical fascia. Myxœdema has been caused by it.

Echinococcus Disease.—Echinococcus disease of the thyroid, though very rare, occasionally occurs. As the cyst enlarges, difficulty of breathing results. These cases, according to Henle, have never been diagnosed before operation. Infection takes place through the circulation or directly through a wound. Free incision is the only treatment. Fatal cases, due to the perforation of the trachea when the cyst was comparatively small, have been recorded. These cases may be confounded with those of cystic goitre, but, even when small, the tumor may give rise to symptoms, while in goitre this does not usually occur. If, when the cyst is tapped, a limpid colorless fluid is evacuated, our suspicions may be aroused, and, if hooklets are found, diagnosis will be assured. But cysts of the thyroid are now rarely tapped or aspirated, enucleation being the more common method of removal.

Benign Tumors of the Thyroid.—These are rare, if we exclude the adenomata seen in goitre. Fibromata and lipomata, though rare, have been noticed in the thyroid.

Malignant Tumors of the Thyroid.—Malignant disease of the thyroid is not a very uncommon affection in goitrous districts, for malignant disease is more likely to attack goitrous than normal thyroids. (Fig. 272.) In an experience of twenty years the writer has seen perhaps a dozen malignant tumors of the thyroid and has operated on seven.

Sarcoma.—Sarcoma of the thyroid is less common than carcinoma. In 7,700 autopsies Chiari, of Prague, found 11 cancers and 5 sarcomata of the thyroid, whereas Limacher, of Berne (a goitrous district), found, in 7,461 autopsies, 44 carcinomata and 38 sarcomata. Tanchon found, among 9,118 cases of cancer, only 8 in the thyroid. It is often very difficult to determine, from an histological examination, whether the case is one of cancer or one of sarcoma of the thyroid, much more difficult than when these diseases occur in other parts of the body.

Sarcoma grows more rapidly than carcinoma, and is seen more often in young individuals. It is rare that a patient with sarcoma lives more than a year. Death is commonly due to infiltration and subsequent compression of the trachea and œsophagus. The growth of a sarcoma is very rapid. The right lobe is the one usually affected. Operation is successful only in very early cases where the surrounding parts have not been involved. In all cases sarcoma is extremely malignant. Morf reports that in forty-five per cent of the cases metastases were present. The cervical lymph nodes seem to be involved as early as in cancer.

Carcinoma.—As is the case in other parts of the body, cancer of the thyroid usually develops in persons past middle life. (Fig. 273.) The form commonly seen is that of adeno-carcinoma or alveolar carcinoma. Epithelioma is rare, as is scirrhus.

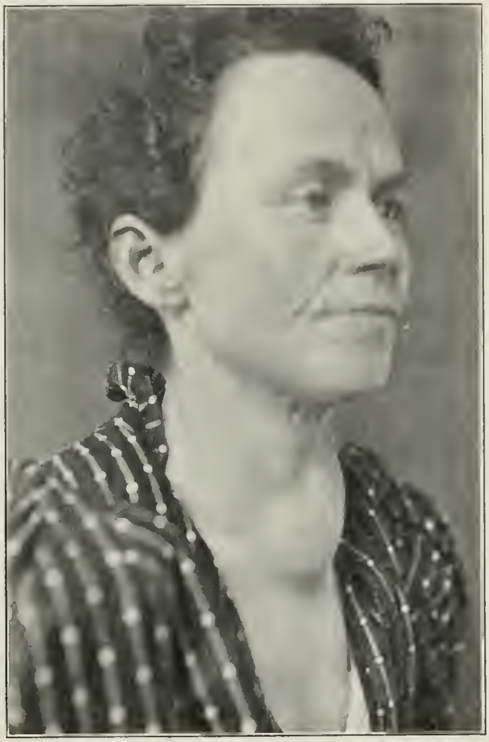

FIG. 272.—Malignant Disease of the Thyroid, Presenting Itself as a Tumor in the Anterior Left Lateral Aspect of the Neck. Recurrence in the lung eight months after the removal of the primary tumor. (Author's Case.)

Carcinoma of the thyroid often commences as a small nodule which gradually increases in size; or it may involve one lobe, or the whole gland.

SYMPTOMS AND COURSE OF THE DISEASE.—Pain is an early symptom of malignant disease of the thyroid, and the growth rapidly infiltrates the tissues, the lower cervical lymph nodes being early involved. Difficulty in swallowing and breathing soon appears, and the increasing pressure on the veins causes œdema and later thrombosis. The involvement of the nerves may cause neuralgia. The capsule is involved early and soon afterward the infiltration tends to produce fixation of the tumor. The trachea may be perforated at a point two or three inches below the cricoid.

The duration of cancer of the thyroid varies much, some cancers growing very rapidly, while others take years before the fatal ending arrives. The rapidly growing ones kill by infiltration, hemorrhage, suppuration, etc. Metastases are common and are histologically much the same as the original tumor, though sometimes these metastases look like normal thyroid glands. Some of the metastases have been removed and this removal has been followed by tetany. It is possible that the parathyroids have been involved in this metastasis, and have thus, when they were removed, produced post-operative tetany. Metastases have been reported in the frontal bone, lower jaw, lungs, etc. The idea of Cohnheim that benign adenomata may form metastases has been disproved by von Recklinghausen, who claims that, in these cases associated with metas-

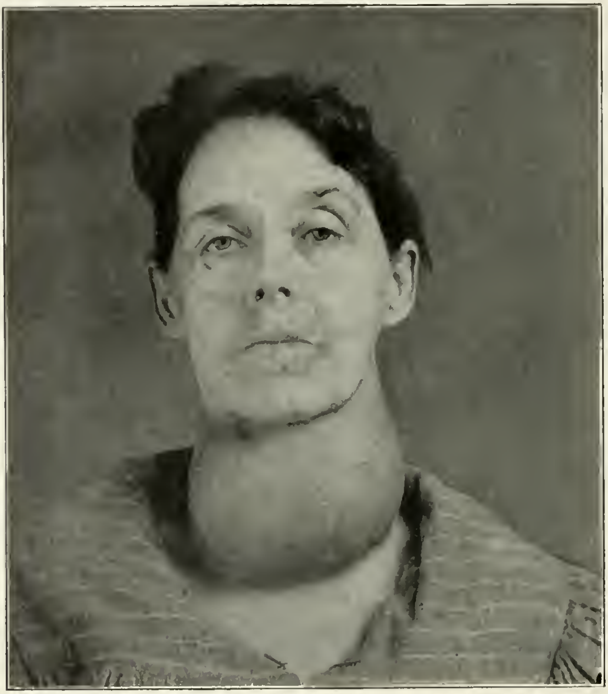

FIG. 273.—Carcinoma of the Thyroid; recurrence in lung within a year after removal. (Original.)

tases, the disease is always malignant. Bloodgood's recommendation, that every asymmetrical enlargement of the thyroid in individuals over thirty should be removed, seems to me to be excellent. The adoption of the plan would lead to the removal of carcinomata of the thyroid at periods when clinically they cannot be differentiated from cysts or adenomata. Kocher has observed—and the writer can substantiate his statement—that, if a patient has suffered from a simple goitre for many years, a sudden enlargement may indicate the possibility of malignant disease, and he advises that, in such a case, operation should be immediately undertaken.

Treatment.—Early and complete removal is the only treatment. When infiltration has taken place, treatment is of little avail. Should the capsule not be involved, the results may be good. In only one case has the writer seen a cure, and this was in a patient with a slow-growing scirrhus of the thyroid. The case was operated on three times. The last time most of the structures on the right side of the neck were removed, viz., the sterno-mastoid muscle, the jugular vein, and the vagus nerve. The patient has now remained well for six and one-half years (1909). After the second operation, however, she developed myxœdema, and in consequence she now has to be constantly fed with thyroid. There never was any suspicion of tetany in this case.

Exophthalmic Goitre.—Synonyms: Parry's disease, 1825; Graves' disease, 1835; Basedow's Disease, 1840; Morbo di Flajani.

The treatment of this affection by operation on the thyroid is a comparatively recent procedure and its usefulness as a means of relieving this serious disease is not yet conceded by all. In many cases operation is contra-indicated, but in others operative measures result in complete cure or great improvement.

Tillaux and Rehn first successfully treated Graves' disease by operation and this has been developed later by von Mikulicz, Kroenlein, Trendelenburg, Wolf, and, more especially, by Kocher, of Berne.

If one believes the theory of Moebius, who holds that this disease is due to excessive secretion and absorption of thyroid fluid, then removal of a large part of the thyroid by operation is a most logical procedure. It is said that, in some ten per cent of cases of exophthalmic goitre, there is no enlargement of the thyroid, and that, in many cases, it is not marked or constitutes only a late symptom. The author has found, in operating, that what seemed to be a very small thyroid, in a patient who presented other well-marked evidences of Graves' disease, was in reality of large size, most of the growth being below the episternal notch. Kocher states, in his lectures on "The Pathology of the Thyroid Gland," given before the Medical Society of London, 1906, that he has never seen a severe case of this disease without an alteration in the thyroid. (See Figs. 274 and 275.) (See also Addenda on p. 400.)

Etiology.—Graves' disease is much more common in women than in men and occurs usually between the twentieth and thirtieth years. It is often preceded by worry, fright, some severe nervous shock, or great depression. Many hold that it is a nervous disease, while others (Horsley, Moebius, *et al.*)

maintain that it is produced by hyperactivity and hypersecretion of the thyroid, and that the same condition can be produced artificially by feeding a person with thyroid extract. In many cases of this disease there is a greatly enlarged thymus, and the writer, in one fatal case, saw very much enlarged adrenals as well.

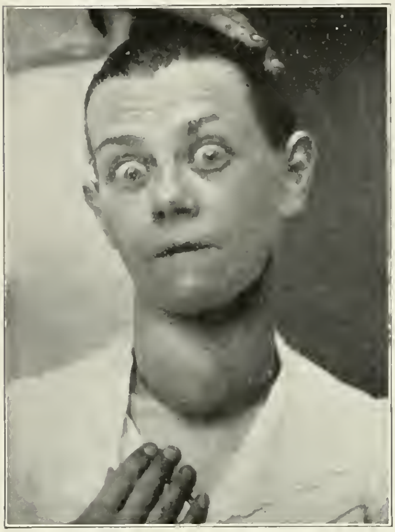

Fig. 274.—Typical Case of Exophthalmic Goitre. (Original.)

SYMPTOMS.—Two[1] forms of exophthalmic goitre are seen, the acute and the chronic.

The acute form, where death ensues in a short time, is not suitable for operation.

The chronic form is of two kinds: (1) Where the enlargement of the thyroid does not precede symptoms characteristic of the disease, but enlarges concomitantly with the development of the disease. In this form the symptoms are more exaggerated and exophthalmos is more constant; operation also in this class of cases is much more dangerous. (2) Where for months and even years a gradual enlargement of the thyroid precedes the symptoms of the disease. In these cases the symptoms are usually less severe, and operation is a much safer undertaking. Kocher calls this "struma Gravesiana colloides."

The chief symptoms in the chronic form are: tachycardia, tremor, emaciation, and excessive nervousness, with enlarged thyroid, which is soft and vascular in the early stages. Exophthalmos is not so constant a symptom as the foregoing. In the early stages there is often rapid swelling of the thyroid, with dilatation of the vessels and a bruit or thrill. There are several signs present even when there is no exophthalmos:—(i) Graefe's sign—that is, when the eyeball moves downward the upper lid does not follow, as it does in health; (ii) Moebius' sign, a lack of convergence of the two eyes without diplopia; (iii) Stellwag's sign, a widening of the palpebral fissure; (iv) Kocher's sign (an early sign), viz., "sudden retraction of the upper lid when the patient is made to look steadily at you or to look upward suddenly." Later, other symptoms develop, such as anæmia, emaciation, slight fever, sweatings, attacks of vomiting and diarrhœa, nervous symptoms, muscular weakness, irritable temper, change of disposition and even acute mania, alteration of the skin, such as pigmentation, leucoderma, dermography, œdema, etc., etc. Myxœdema is sometimes a late symptom, due probably to the colloid changes in the gland.

The disease usually lasts for several years. About thirteen per cent die. A certain number get well, but it is rare that a well-developed case is cured spontaneously. In many cases the neighboring lymph nodes are much enlarged from which fact it is inferred that the secretion of the thyroid is greater and that the lymph nodes are subjected to a correspondingly increased degree of irritation, with more lymph passing through the vasa afferentia.

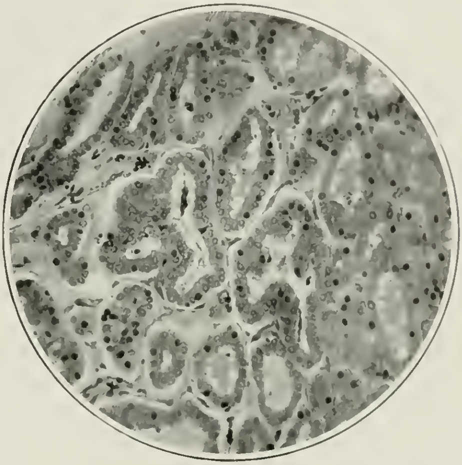

FIG. 275.—Section of an Exophthalmic Goitre, showing so-called typical appearance; magnified about 1,000 diameters. (Original.)

TREATMENT. — Kocher holds, and many surgeons agree with him, that by taking away the diseased thyroid we can absolutely cure Graves' disease except in those cases in which secondary changes have taken place in the fatty tissues of the orbit, in the cardiac muscle, etc. He says: "the improvement in the patient's condition is in exact relation with the amount of hypertrophied tissue we take away or destroy by our operation—that is to say, with the amount of diminution of the function of the gland produced." It is important to operate in properly selected cases. Operation in the early stage of the disease is almost without danger. In every case of Graves' disease the patient should be properly prepared by medical treatment for some weeks before operation. Kocher advises small doses of iodine for a short time and the continuous use of phosphates (sodium phosphate, 2–10 grammes daily), together with absolute bodily and mental rest. In the writer's experience no drug has been of any benefit; but rest and an ice-bag over the heart have been of great service. In severe cases Kocher advises, first, ligature of one superior thyroid artery, followed by ligature of other arteries ten days later. Then, after some weeks, when the symptoms of the disease show a decided diminution, excision of one-half of the gland should be performed. In all his operations Kocher uses local anæsthesia and says that general anæsthesia is very dangerous in cases of great dilatation of the heart due either to overwork or to toxic fatty degeneration.

The danger of death from acute thyroidism after operations in Graves' disease is well known. If the heart has undergone degenerative changes it may suddenly fail. After operation the temperature rises and the tachycardia is increased. In fact, there is a sudden increase of intoxication and all the ordinary symptoms of Graves' disease may be greatly exaggerated. It is thought that manipulations of the gland during operation tend to produce increased absorption of thyroid secretion. It is also found that the danger is often as great when the vessels are simply ligated. Verebegy has shown that this is due to a great increase of reabsorption by lymphatics when the veins are tied. The symptoms are much less pronounced when the arteries only are ligated. According to Halsted, of Baltimore, and also Chas. Mayo, of Rochester, Minn., it is dangerous to tie all four or even two arteries, for the parathyroids are nourished from these sources (especially from the inferior thyroid); and consequently, if the vessels are tied, the parathyroids, being thus deprived of their nutrient vessels, perish and give rise to tetany. Halsted advises a most careful ligation of the branches of the thyroids close to the thyroid gland and beyond the point where these parathyroid vessels are given off.

The author has operated on twenty-five cases of severe Graves' disease, with three deaths. In two the patients were in the neighborhood of sixty years of age, and both had long-standing disease with secondary changes in heart, etc. In these two cases the patients were operated on at their own earnest solicitation and against the author's better judgment. One died, twelve hours after operation, of thyroidism; and the other, a week afterward, of pure asthenia, and at the post-mortem examination most of her organs were found diseased. The patients who recovered have, with one exception, been completely cured of their disease.* Kocher, in the last 1,000 operations in ordinary goitre, had 3 deaths; in 176 cases of Graves' disease, 9 deaths. Only 106 of these cases were looked upon by him as instances of true Graves' disease; the other 70 cases—10 of early vascular goitre, and 60 of what he calls "struma Gravesiana colloides"—were examples of a modified form of Graves' disease, cases in which an ordinary goitre had existed before the appearance of Graves' symptoms. In these 70 cases he had no deaths.

Dr. Crile, of Cleveland, believes that "psychic excitation" is the most dangerous factor in operations for Graves' disease, and is the chief cause of the hyperthyroidism of which patients suffering from this disease die after operation. To avoid this "excitation" he obtains leave from the patient's friends to do what he thinks proper in the treatment of the case, and then does not tell the patient that he is going to operate for the relief of the symptoms. For some days before the operation he makes the patient inhale some essential oil in an inhaler, at the same time applying to the neck antiseptic dressings. On a given morning he substitutes an anæsthetic for the essential oils and the patient, when under its influence, is operated on without any knowledge of what is to take place: and in fact, when she becomes conscious, she is not aware that an operation has taken place. In all the cases thus operated on (over a dozen) recovery has been the rule. This method he applies only to the most severe cases, not to those of the subacute or acquired variety.

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* In connection with the above, the diagnosis of true Graves' disease differs according to the opinion of the observer. The severe cases can be mistaken by no one, but many surgeons class as cases of Graves' disease those in which there are tachycardia, slight exophthalmos, perhaps some tremor, etc. These cases are regarded by the writer as doubtful, and, although he has operated on many such, they are not included in the twenty-five above mentioned.

To avoid the toxæmia following operation, in exophthalmic goitre, Chas. Mayo advises saturating the patient with water, either by mouth or by the rectum, or both, and, if the patient is uncontrollable, by subcutaneous injections. Halsted suggests the application of severe cold to the wound after operation, even to the extent of freezing the skin. He also suggests leaving the wound open and continuously irrigating with very cold water, believing that it is not only hyperthyroidism that has to be contended with, but other forms of toxins also, incident to wound healing.

Other surgical measures than excision have been from time to time advocated. Such are, for instance: ligature of the four thyroid arteries; exothyropexy, or exposure of the gland without excision; and excision of the sympathetic, advocated by Jaboulay. Exothyropexy has been abandoned; excision of the sympathetic has failed to fulfil expectations, and the only symptom which it has relieved is the exophthalmos—the tachycardia and tremors persisting. Few now practise this mode of treatment.

In the early vascular cases Kocher has had good results with small doses of iodine and phosphates. The serum treatment has been much in vogue of late; it can claim some successes, but has had many failures. Its advocates say that it is an excellent palliative, and that the pulse rate is reduced and the weight increased. The results are not permanent and the treatment has to be repeated from time to time. The serum is obtained from the blood of thyroidectomized goats and sheep. The writer has had no experience with it and can offer no opinion; still, it is worthy of trial before proceeding to operative measures.

X-rays have been used with some success in these cases; the gland has been reduced and the pressure symptoms have been relieved, but no cure has resulted. It is sometimes useful to employ *x*-rays before operation for the purpose of lessening the severity of the symptoms. Goerl reports eight cases treated by *x*-rays; in some the tumor entirely disappeared, in all others there was a diminution of the growth. The exposure was made every three or four days at a distance of 10 cm., and was continued for ten minutes.

Radium has been used by some to reduce the size of the gland, and Abbe reports improvement in a few cases.

A few words as to the choice of an anæsthetic. A mixture of ether and chloroform, 2:1, has been used by the writer with the best results, and as yet no death or alarming symptoms have resulted. Of course, where there is grave heart lesion, if operation is determined on, local anæsthesia might be preferable, but von Eiselsberg had a death from local anæsthesia which he says was exactly like one from chloroform, so that it is not absolutely safe. General anæsthesia carefully administered by an expert need not be dangerous. Local anæsthesia in a patient under high nervous tension, as is the case in these patients, and especially if this tension be prolonged, appears to be a procedure which will not tend to improve the condition.

Struma Gravesiana Colloides (Pseudo- or Acquired Graves' Disease).—This is the name that Professor Kocher gives to a variety of Basedow's or Graves' disease. (Fig. 276.) In this form of the disease the goitre has, in all cases, existed before the development of the characteristic symptoms of Graves' disease—symptoms "which are, so to speak, grafted on the common form of colloid goitre." The symptoms are less severe than in true Graves' disease; exophthalmos may be wanting and the dilatation of the heart is less. It is really a mitigated form of Graves' disease. Dr. Albert Kocher says that ordinary colloid material is to a certain degree an antidote for exophthalmos; hence there is not so much hyperplasia in proportion to the colloid as in the severer forms.

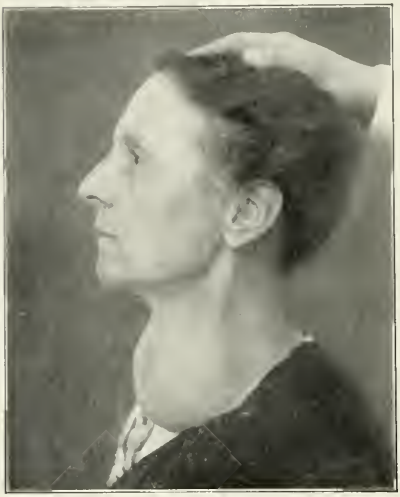

Fig. 276.—Photograph of a Patient with Struma Gravesiana Colloides. Pulse 120; tremors; restlessness; great nervousness and no exophthalmos. (Original.)

Professor Kocher has operated on sixty of these cases without a death.

Microscopically this form can be usually recognized by "the transition of the one form into the other by the elevation of the epithelium and the formation of low papillæ." (Kocher.)

In advanced stages of true Graves' disease, where secondary changes have taken place and where there are vomiting, diarrhœa, and great restlessness, with excessive tachycardia and considerable dilatation of the right heart, operation should not be advised, but means other than operative should be undertaken.

Surgical Treatment of Goitre.—Complete excision of a goitre should never be undertaken, for fear of the effects on the individual, namely, the production of myxœdema or cachexia strumipriva. It is also important to avoid, if possible, removing the parathyroids, which are usually located behind the gland, the lower pair being in close relation with the inferior thyroid arteries. The proof is now almost complete that removal of the parathyroids causes tetany and that the individual cannot live without them;* also that complete removal of the thyroid causes myxœdema, which, when it occurs, can be relieved by the administration of sheep's thyroid. What was formerly a most dangerous operation is now, owing to improved technique, regarded as comparatively safe, and the danger of post-operative myxœdema is avoided by leaving behind a portion of the gland.

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* Dr. Halsted, of Baltimore, has lately reported a case of tetany after operation, which was relieved by the daily eating of the parathyroids of the ox.

As a rule, in operation for goitre only the diseased part should be removed, and usually the disease is confined to one or other lobe, most commonly the right.

Indications for Operation.—The indications for operation in simple goitre are:

1. Progressively increasing size of the tumor.
2. Rapid growth of the tumor, with dyspnœa on exertion or when bending forward; also attacks of difficult breathing coming on paroxysmally.
3. Narrowing of the trachea.
4. Difficulty in swallowing.
5. Alteration of the voice.
6. Tachycardia and nervousness, coming on perhaps after the patient has experienced for years no inconvenience from the enlargement.
7. Inconvenience and deformity owing to the size of the growth.

Anæsthesia.—Before the methods of operating are described something should be said about anæsthesia. The majority of continental surgeons who operate much on goitre now prefer local anæsthesia. Kocher, Reverdin, Socin, and other Swiss surgeons use general anæsthesia only in a very limited number of cases, preferring local anæsthesia. Some surgeons also in this country have adopted this method and say that, after the skin incision is made, the operation is not painful. From what the writer has seen, many of these patients suffer severe pain, while others scream and are extremely nervous, all of which disturbs the operator and the operation and renders the administration of an anæsthetic necessary. In Switzerland the patients who suffer from goitre seem to be more phlegmatic and less sensitive than patients on this side of the Atlantic. The advantages claimed are, first, the avoidance of the dangers of general anæsthesia, and secondly, the lessened risk of wounding the recurrent nerve by making the patient articulate during the operation. So far, the author has not felt inclined to adopt local anæsthesia, for no deaths or even alarming symptoms have occurred in any of his cases. He has used now for some years a mixture of two parts of ether and one of chloroform, and has found it in every respect satisfactory. Before the operation is begun full anæsthesia should be induced, but toward the end of the operation the patient should not be profoundly anæsthetized. Care should be taken not to handle the recurrent laryngeal nerve, for considerable shock may thus be induced. The danger of general anæsthesia has been much exaggerated, and, with care on the part of the operator and the anæsthetist, no great risk is run. Kocher operated on nine hundred cases in which he used chloroform without a death.

Kocher says in his "Operative Surgery": "Notwithstanding all aseptic precautions and improved technique we may lose our patients, after excision of the thyroid, where one or other of the following conditions exists:

"1. Tracheal stenosis of long duration. . . .

"2. When the cardiac tone has been weakened by other causes, such as general adiposity with fatty heart, atheroma, venous stasis, etc.

"3. Marked interference with the venous circulation owing to pressure of the growth. . . .

"4. When the entire thyroid is in a state of diffuse follicular colloid degeneration, with a minimum of healthy gland. Such goitres are often of large size and surround the trachea as a dense mass which is but slightly movable. Excision is difficult and bloody."

Kocher advises, in this class of cases, that the vessels should be first ligatured, and that, later on, when the tumor has diminished, a unilateral excision should be performed. In these cases, if removal of the whole thyroid be undertaken, acute tetany may set in,—an occurrence which may rightly, as it seems, be attributed to removal of the parathyroids, which in such cases may possibly be closely united with the thyroid.

"5. In cases of extreme Graves' or Basedow's disease, with great emaciation and marked tachycardia. These patients may die in a few days although the wound be perfectly healthy."

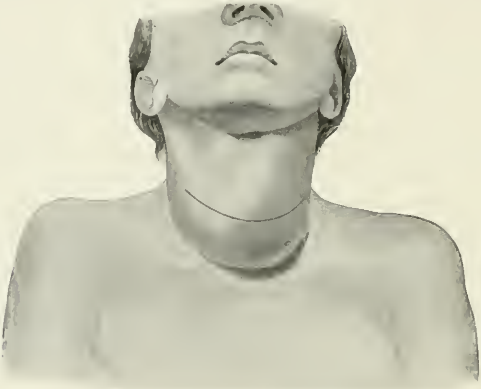

FIG. 277.—Symmetrically Arched Transverse Incision, for Use in Excising a Diseased Thyroid Gland. (After Kocher.)

Here, again, Professor Kocher advises preliminary ligature of the arteries, excision being performed later.

"6. When the tumor is malignant, with marked infiltration and signs of thrombosis, and when there is a general deterioration, operation is of little avail."

Better results, he believes, will be obtained by the administration of arsenic.

"7. When the goitre is inflamed, the inflammation involving the capsule and the adjoining structures."

Removal of the thyroid in these cases of acute inflammation renders the patient liable to a spreading wound infection. In chronic inflammatory conditions removal of the gland is often attended by severe hemorrhage due to the numerous adhesions

In such cases as are referred to above undue delay in operating is the chief cause of the dangers.

The Operation.—There are two methods of operating: (1) partial excision

—*i.e.*, excision of half or three-fourths of the gland; and (2) enucleation of the various nodules and growths in the gland, as first recommended by Socin.

1. Partial Excision.—There are several incisions which are practised: (i) The transverse incision of Kocher; (ii) the oblique incision; and (iii) the longitudinal incision along the inner side of the sterno-mastoid.

The Kocher incision (Fig. 277) is made over the most prominent part of the tumor and is a slightly curved transverse incision with the concavity upward; it extends from the outer part of one sterno-mastoid to a corresponding point on the other. By this incision the skin and platysma are divided and the fascia, with the two anterior jugular veins, is exposed. These veins should be divided between two ligatures. The fascia, vessels, and skin are now separated upward and downward from off the muscles which are seen between the two sterno-mastoids. The muscles are separated vertically in the middle line and may have to be divided. (Plates XLIV, XLV, and XLVI.) Chas. Mayo advises cutting the muscles near their hyoid attachment between two clamps which are left attached until the muscles are sutured. The writer has seldom found division of the muscles necessary, and it should be avoided if possible. (In all the other incisions, from this point onward, the operations are practically the same.)

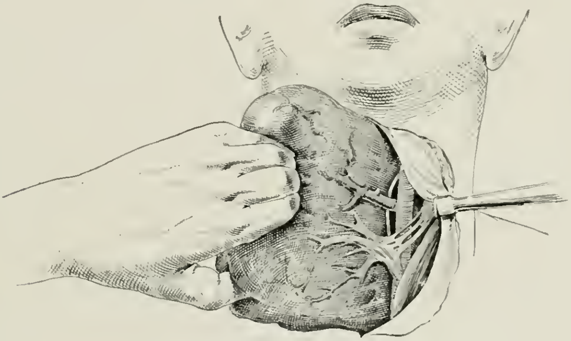

FIG. 278.—The Tumor Delivered. The recurrent laryngeal nerve is shown in its relation to the inferior thyroid artery. (After Kocher.)

The fibrous capsule of the goitre should next be divided and the goitre delivered by sweeping the finger or, if preferred, a blunt instrument—Fig. 282,—round the tumor; the bands which are encountered, as the finger passes between the tissues and the gland, and which contain veins, should be divided between ligatures, and then dislocation is accomplished by pulling the gland forward. (Fig. 278.) The writer prefers, when possible, first to ligate the superior thyroid vessels and cut them across, thus freeing the upper cornu and allowing the goitre to be delivered with greater ease. As soon as the tumor is delivered, pressure is removed from the trachea, severe dyspnœa is relieved, and the breathing at once becomes easier. Now the tumor should be pulled to the opposite side and the muscles retracted outward, in order that the inferior thyroid artery may be brought into view. The vessel can be felt pulsating close to the muscles and behind the carotid, from which point it crosses somewhat upward to join the goitre about the level of the lower part of the cricoid cartilage. The main trunk of the vessel may be secured or the branches may be tied separately close to the tumor,* and then the inferior laryngeal nerve should be looked for. (Fig.

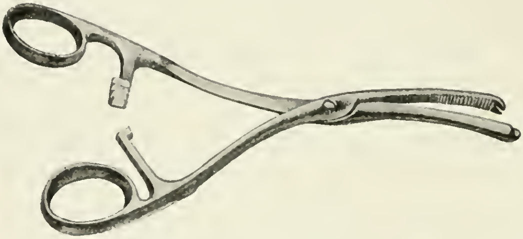

Fig. 279.—Kocher's Forceps for Use in Compressing the Isthmus of a Diseased Thyroid Gland before a Ligature is Applied to the Part.

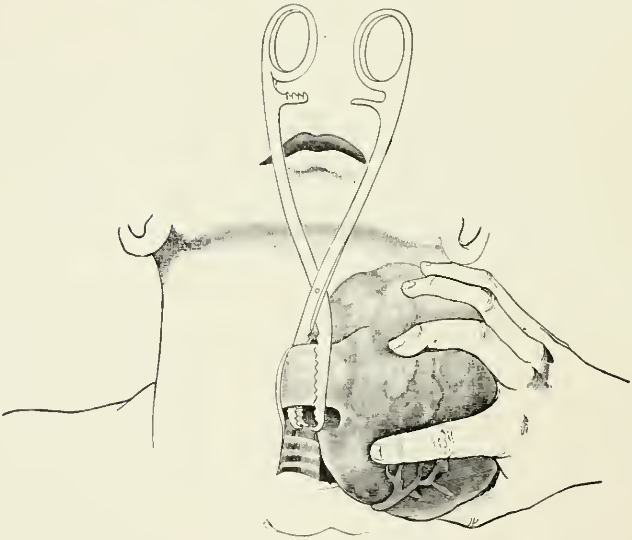

Fig. 280.—Kocher's Forceps Applied to the Isthmus of a Goitrous Tumor. (After Kocher.)

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* Halsted, of Baltimore, insists very strongly upon this point, viz., that the main trunks of the arteries should never be tied but that the branches should be ligatured close to the tumor, as in this way the vessels which supply the parathyroids will not be injured and their nutrition not interfered with.

EXPLANATION OF PLATE XLIV.

THE OPERATION OF THYROIDECTOMY.

(From Kocher's "Chirurgische Operationslehre," 1907.)

Fig. 1.—Skin, platysma, and fascia divided. Anterior jugular vein showing, and deep down the sterno-hyoid and thyroid muscles.

Fig. 2.—The fascia between the sterno-hyoid muscles divided, the finger beneath the sterno-hyoid muscle. The upper end of this muscle cut.

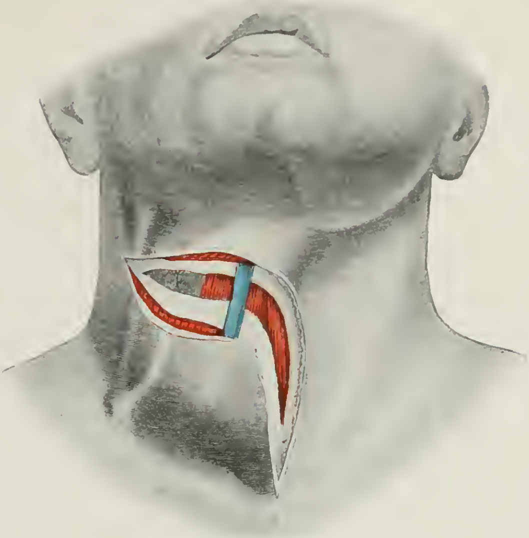

Fig. 1

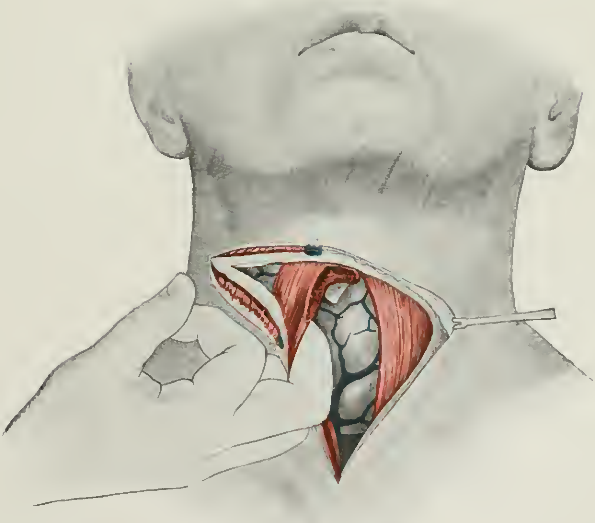

Fig. 2

FIRST AND SECOND STAGES OF KOCHER'S THYROIDECTOMY BY THE ANGULAR INCISION, FOR DIFFICULT CASES.

278.) It is usually seen running closely alongside the trachea in immediate relation with the branches of the inferior thyroid artery, either behind them or going in and out among them. The nerve, when seen, should not be interfered with, and it is often well to leave behind, if possible, that portion of the gland which is in its immediate neighborhood.

There is sometimes seen a thyroidea ima artery, with the accompanying veins, entering the lower pole of the tumor. These should be carefully looked for and, when found, they should be divided between two ligatures. The isthmus must now be separated from the trachea, and this can be done with a blunt elevator. (Fig. 282.) Kocher's forceps (Figs. 279 and 280) should now be applied and the isthmus crushed; then, after the removal of the forceps, the tumor should be tied off with strong catgut ligatures and removed. Too much care cannot be taken to arrest all hemorrhages and to avoid the least injury to the recurrent nerve.

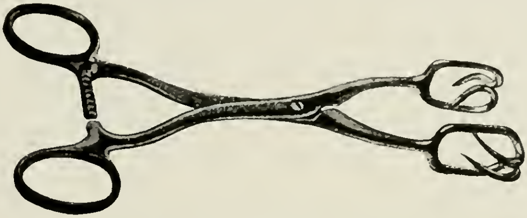

Fig. 281.—Kocher's Clamping Forceps for Use in Operation upon Tumors of the Thyroid Gland. (This instrument possesses the advantages of not causing any hemorrhage and of not slipping after the blades have been applied to the tumor.)

The wound may now be washed out, or not (according to the practice of the operator), with saline solution; all divided muscles should be sutured, and the edges of the wound should be brought together. Some operators prefer to introduce a drain, while others employ light packing with iodoform gauze. These are removed at the end of twenty-four hours. The writer prefers to employ iodoform gauze, as its use lessens the danger of hemorrhage and also because it diminishes the tendency to thyroidism, which may come on after operation.

Fig. 282.—Kocher's Spoon for Use in Separating an Intrathoracic Tumor or the Thyroid Gland from its Deeper Attachments. (After Kocher.)

In this operation it is always important to recognize the capsule proper of the gland, which experience easily enables one to distinguish by its peculiar bluish-red color and by the number of small and distended veins that run over its surface. It is very important not to cut into the capsule, for, if this is done, profuse and often alarming hemorrhage occurs, and it is almost impossible, owing to the friability of the tissue, to place ligatures on the bleeding points. Should this accident occur, it is better rapidly to dislocate the gland, in spite of hemorrhage, and to secure the thyroid arteries. By keeping close to the capsule we avoid removing the parathyroids. Chas. Mayo advises leaving the posterior capsule; he calls this method *subcapsular excision.*

High temperatures after operation are common; they are said to be due to too much handling of the gland, but this has not been proved, as they occur when there has been little handling, whilst in other cases where there has been much handling, elevation of temperature does not occur. Difficult breathing after operation ought to be carefully inquired into. It may be due to various causes—a hemorrhage, accumulation of mucus, too tight dressings, and also expansion of the packing owing to its becoming soaked with blood or exudate. After operation there is usually painful deglutition, but this passes off in a day or two.

Should it be necessary, owing to disease or hemorrhage, to remove the remaining lobe of the goitre, this can be easily done through the same incision, the excision of the larger half of the tumor facilitating the removal of the other. The vessels and nerves are usually found here more easily than in the first half removed.

With regard to *incisions,* the author has always used the vertical incision along the side of the sterno-mastoid and over the most prominent part of the tumor. In very large goitres the incision is continued, at its lower end, to the opposite side, immediately above the suprasternal notch, in a curved direction, with its concavity upward. In goitres which extend far up Kocher advises an angular incision. He says: "This begins at the level of the thyroid cartilage over the prominent part of the sterno-mastoid and is carried forward to the middle line, following the fold of the neck, and then vertically downward as far as the suprasternal notch." This incision is useful in diffuse colloid tumors, in inflamed goitres, and in cases of malignant disease.

Enucleation of the Goitre.—Enucleation, introduced by Porter and strongly advocated by Socin, is suitable only in a very limited number of cases. The advantages claimed are:—(i) Rapidity and comparative bloodlessness of the operation; (ii) the fact that only the diseased portion of the gland is removed, so that there is no chance of post-operative cachexia strumipriva occurring; (iii) the comparative safety of the method and the absence of risk of wounding the recurrent laryngeal nerve; (iv) the comparative simplicity and ease with which the operation is performed; and (v) the avoidance of the danger of removing or injuring the parathyroids.

It was formerly the writer's opinion that, in cases of simple cystic or adenomatous goitre, enucleation was the best operation; but a further experience has convinced him that, in such cases, there is danger of secondary hemorrhage. This accident occurred in two cases and gave rise to great anxiety. He therefore practically abandoned the method and now makes use of it only in small adenomatous tumors or single cysts, or in cases where one-half of the thyroid has

EXPLANATION OF PLATE XLV.

THE OPERATION OF THYROIDECTOMY.

(From Kocher's "Chirurgische Operationslehre," 1907.)

Fig. 1. The capsule of the thyroid is divided and the gland pulled over to opposite side. The sterno-thyroid and sterno-hyoid muscles are cut through and pulled aside. The carotid artery and trachea are seen and also the inferior thyroid artery and the recurrent laryngeal nerve.

Fig. 2. The fibrous capsule is pulled upward and the superior thyroid vein and artery isolated by means of the goitre dissector. The cut end of the sterno-hyoid is seen above.

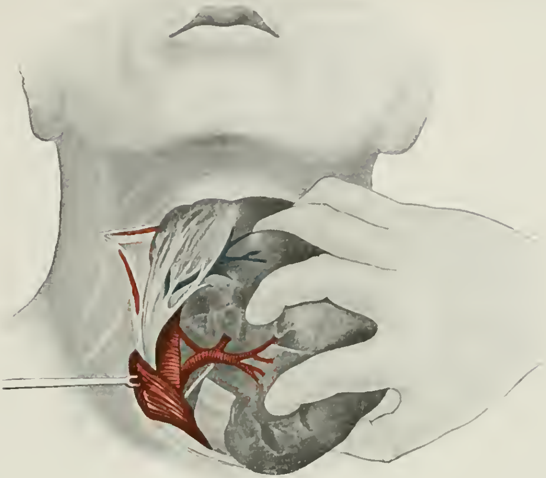

Fig. 1

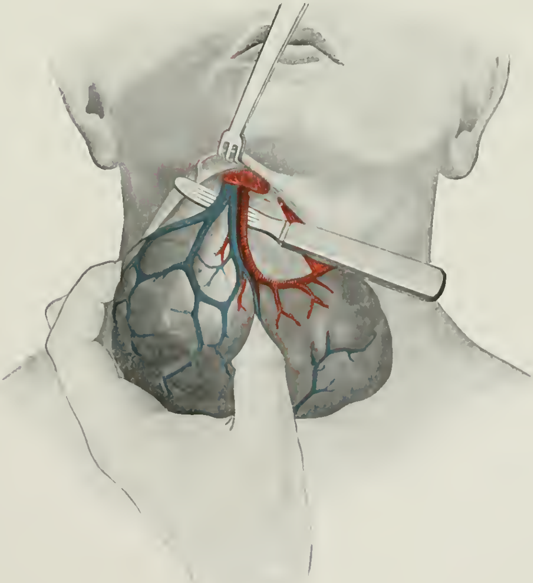

Fig. 2

THIRD AND FOURTH STAGES OF KOCHER'S THYROIDECTOMY BY THE ANGULAR INCISION, FOR DIFFICULT CASES.

already been removed. In large single cysts it is not always possible to identify the capsule proper of the thyroid, and in these cases enucleation of the cyst is in a way obligatory; it is also necessary in goitres that are very adherent to the external capsule, as a result of inflammation. Another objection to this operation is the frequency of recurrence of the goitre.

The Operation.—The method of operation is as follows:—An incision is made over the most prominent part of the tumor and the capsule covering it is recognized by its bluish-white color; but only experience will teach the operator when he has reached the proper layer for enucleation. Reverdin says: "When one is doubtful, it is not the capsule of the growth." The tumor should be rapidly enucleated by the aid of the finger or a blunt instrument, preferably the former if the tumor shells out easily. There is usually little hemorrhage, but sometimes there are adhesions, and then a copious hemorrhage follows. In such cases, if the bleeding cannot be controlled with hæmostatic forceps, the vessels supplying the gland should be tied. If there is difficulty in shelling out the tumor or cyst, evacuation of the semisolid and fluid contents enables the operator to separate the capsule from the gland without much loss of blood. Relaxation of the tension enables one to pull up the gland and so make the operation an extracervical one.

It is well to pack the cavity which was occupied by the tumor with iodoform gauze, and then to remove it at the end of twenty-four hours.

These cases, when there is no secondary hemorrhage, heal very rapidly, the patient frequently going out of hospital in five or six days.

In many cases of large multilocular cysts the author, after tying and cutting away the superior thyroid vessels, delivers the gland and then enucleates the diseased portions. This leaves a thin layer of gland behind and protects the operator from the risk of wounding the recurrent nerve, of producing myxœdema, or of removing the parathyroids.

Dangers of Thyroid Operations.—Before the days of antiseptic surgery the operation of thyroidectomy was looked upon with dread, and the mortality was very high from sepsis, hemorrhage, pneumonia, and also tetany and myxœdema. With the introduction of modern antiseptic and aseptic surgery and improved methods for arresting hemorrhage, the mortality, in cases of simple goitre, has been reduced to a very small percentage. Reverdin, in 6,103 cases, gives a mortality of 2.88 per cent. In Kocher's last series of 1,000 cases he lost only 3, and had 272 consecutive cases without a death. Reverdin, in his statistics (6,103 cases), gives the number of deaths as the result of the operation as 93. Of these there died from suffocation, asphyxia, or pneumonia, 42; from hemorrhage, 19; from syncope, 6; from myxœdema and tetany, 4; from infection, 13; and from nervous conditions, such as shock, or injury to recurrent nerves, 9.

As to the mortality accompanying the different methods of operating, Reverdin places it in intraglandular enucleation at 0.78 per cent; in combined enucleation and resection, at 2.92 per cent; in partial excision, at 3.16 per cent.

Hemorrhage.—One of the greatest dangers in thyroidectomy is hemorrhage. Hemorrhage must be stopped at all hazards at the time of operation, and, to do this effectually, the patient's arteries must be tied. Every bleeding point should be tied with catgut before the wound is closed, and the patient, in hemorrhagic cases, should be carefully watched afterward. Care also should be taken in removing the gauze packing, the removal of which is occasionally accompanied by free bleeding. The only cases where the writer has seen secondary hemorrhage have been those where the tumor was removed by enucleation. In these cases the wound should be reopened, the clot turned out, and the bleeding points, if possible, seized. If this is impossible, the writer has successfully arrested secondary bleeding by packing the wound with lint soaked in the tincture of the muriate of iron.

Asphyxia.—Asphyxia may occur during operation in cases where there is a scabbard-shaped trachea, or where the trachea gets kinked in delivering the tumor. Kocher has, in cases of a scabbard-shaped trachea, placed sutures on each side and tied them over the anterior wall of the trachea, which is usually very firm. This method of applying sutures keeps the tracheal tube open. When there is dyspnœa during the early stages of the operation, this is, as a rule, rapidly relieved by delivering the tumor. Tracheotomy should never be resorted to except under special necessity, on account of the danger of infection. The author has only once resorted to it and then, after three days, he was able to remove the tube and the patient did well.

Wounding of the Œsophagus.—The œsophagus has been injured during this operation, but a disastrous result has been avoided by immediate suture. However, if a fistula appear after operation, the result is usually death, due to infection.

Injury to the pleura has been reported, as has also entrance of air into the veins. The writer has never seen either of these accidents.

Injury to Veins.—In cases of air embolism a whistling noise is heard. The wound should then at once be packed with gauze, and the wound in the vein carefully looked for. Treves advises flooding the wound with salt solution. Koenig advises cardiac massage. Should the case not be immediately fatal no harm may result.

Injury of the Recurrent Laryngeal Nerve.—It is always important before operation to know the condition of the larynx, and it should be carefully examined. Not infrequently one cord is found to be motionless, owing to pressure paralysis of the nerve. If this has lasted for some time atrophy may have taken place, and recovery of the nerve is then impossible. In the writer's experience the left nerve is most often paralyzed, and this is generally on the side opposite to that on which the largest of the tumors is located. Knowing that one nerve is paralyzed the operator will necessarily take more care not to wound the remaining nerve. As soon as the goitre is delivered, the nerve should be looked for, and is by practice easily found. It runs up close alongside the trachea and should be made out before the inferior thyroid artery is ligated. The nerve of one side, perhaps, is more often injured than is supposed, for, if the other nerve is healthy, the cord of that side moves over to the injured side and compensates, so that very little difference will be noticed in the voice. Only once has the

EXPLANATION OF PLATE XLVI.

THE OPERATION OF THYROIDECTOMY.

(From Kocher's "Chirurgische Operationslehre," 1907.)

FIG. 1.—The goitre is freed. The tumor is pulled upward and the right inferior thyroid vein is isolated with an aneurism needle.

FIG. 2. The gland having been cut free from all the large blood-vessels, the goitre dissector is placed under the isthmus to make a way for the crushing forceps.

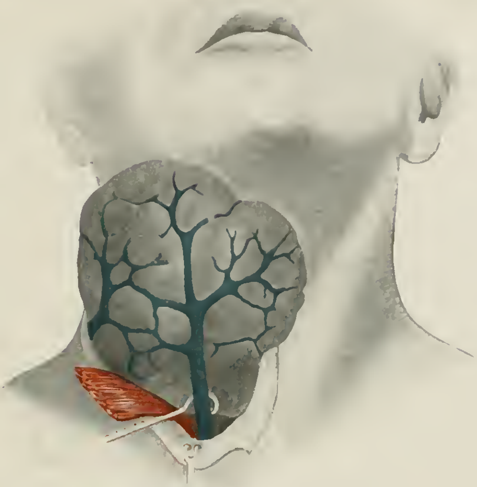

Fig. 1

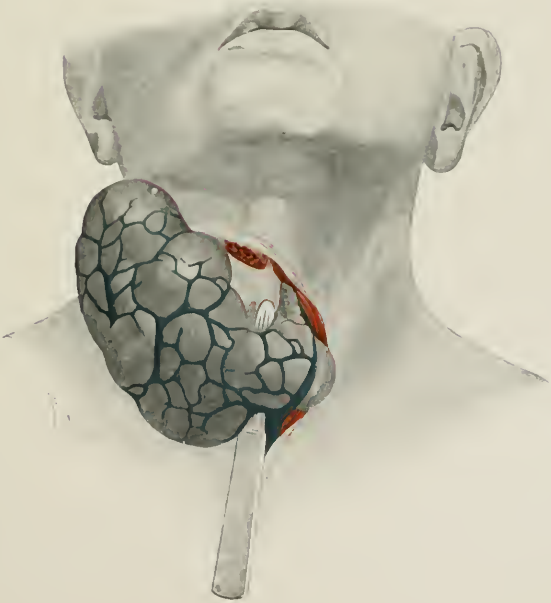

Fig. 2

FIFTH AND SIXTH STAGES OF KOCHER'S THYROIDECTOMY BY THE ANGULAR INCISION, FOR DIFFICULT CASES.

author divided the recurrent nerve, and in this case, the opposite nerve being healthy and immediate suture having been performed, no harm resulted. Kocher, in 1,000 cases, observed alteration in the voice in only 7 per cent; Jankowski's statistics give alteration of the voice in 14 per cent of the cases. This alteration may be only temporary, owing to partial injury or to recovery of an already paralyzed nerve due to removal of the pressure. Stierlin has lately drawn attention to the fact that the nerve may become paralyzed some days or even months after operation, probably as a result of its involvement in the scar. The writer has seen one such case.

The nerve is injured by division, by inclusion in a ligature or in the grasp of forceps, or by rough handling. Traction on the nerve has been observed to produce severe shock, which has resulted in death. Division of both nerves has been reported; and, when this happens, loss of voice and probably a fatal ending from deglutition pneumonia may be expected.

Infection.—Infection may occur during or after operation and is to be dreaded. In many cases there is a moderate degree of infection, which goes on to a favorable termination. The author has seen an acute gangrenous condition follow operation in malignant cases, where there was already infection of the tumor.

Acute Thyroidism.—A rise of temperature after operation is common and occurs in from sixty to eighty per cent of patients operated upon, and is not due altogether to sepsis, but chiefly to the entrance, into the circulation, of glandular elements, ferments, etc., during operation or afterward. The temperature often rapidly subsides after some aseptic fluid has been removed from the wound. This condition of thyroidism may come on after operations on other parts of the body, and many cases—some of them with a fatal termination—have been reported. Pneumonia may occur after operation and be due to sepsis, to aspiration of mucus, etc., produced by injury to nerves, by the tracheotomy wound, etc. The writer has seen only one case and this terminated favorably. In old people the prognosis is most unfavorable.

Difficulty in Swallowing.—Difficulty in swallowing always follows operation, but it usually disappears in a few days.

Dyspnœa.—Dyspnœa after operation may be due to hemorrhage, accumulation of mucus, too tight bandaging, or too firm packing with gauze which has become soaked with blood or exudate.

Post-Operative Myxœdema (Cachexia Thyreopriva).—According to the London Myxœdema Commission, out of 227 total excisions of the thyroid this accident occurred only in 24 per cent. But the Swiss and German surgeons have seen it occur much more frequently. Kocher says 70 per cent; but at a later date he says that he has seen it in all cases of total extirpation. Garre reports myxœdema in 50 per cent of total removals. The writer, in 25 cases of apparently total extirpation, has seen myxœdema only once and this in a case of malignant disease. Four years later, this patient was still alive and still taking sheep's thyroid. It is said that, in regions where goitre is not common, tetany is more apt to occur, and that, in districts where goitre is endemic, myxœdema is more common. (See Fig. 283.)

About 1883 Reverdin, who had continued to observe for several years the after-condition of patients who had been operated on for goitre, reported that he found, in about twenty per cent of the cases, a curious condition something like myxœdema. There were slight weakness and coldness of the limbs, slowness of speech, loss of appetite, loss of memory, sleepiness, anorexia, and often a peculiar œdema, most marked in the face. He thought that this condition was due to a lesion of the vasomotor nerves. It was then found that, in cases where this condition existed, the whole gland had been removed. The report of the Reverdins did not attract the attention which it deserved, and it was not until the following year, at the Twelfth German Surgical Congress, when Kocher read his communication on "Cachexia strumipriva," that surgeons became alive to the symptoms produced by total extirpation of the thyroid gland. The symptoms of this chronic form of myxœdema are easily recognized, and may not come on for months or even years (Eiselsberg) after the operation.

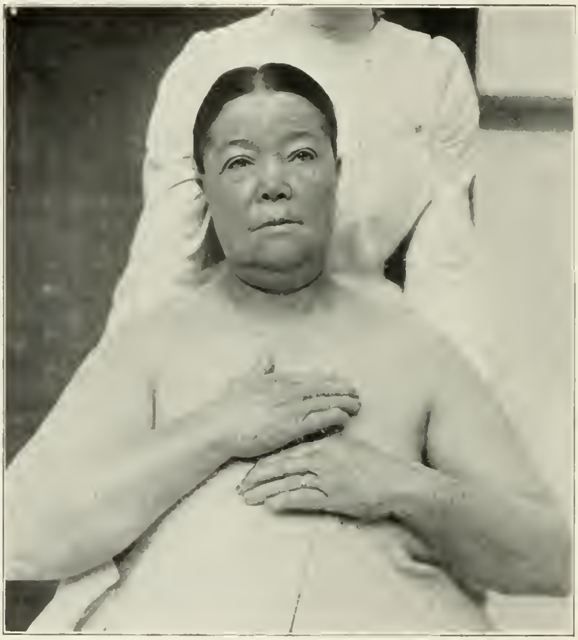

Fig. 283.—Photograph of a Case of Myxœdema. (Original.)

The disease develops slowly. First there is loss of energy, and the patient becomes slow and stupid and can be aroused with difficulty. Memory fails and the senses are less acute; movements are awkward and slow. The hair gets thin and colorless, and the skin dry, white, and thickened; the face becomes expressionless, the lower eyelids become puffy. The patient suffers from cold and keeps close to the stove or heater even in a warm room. Above the clavicles the skin is much thickened and resembles a lipoma. The mucous membrane of the mouth may swell and interfere with speech. The red blood corpuscles are diminished in number and there is leucocytosis. In complete operations on the young these symptoms are more apparent. The long bones cease to grow, and if the epiphyses are ununited they remain so. Puberty may be retarded or prevented. Of course there are many degrees of this condition and in partial excisions a modified form of this disease has been seen.

TREATMENT.—Feeding with fresh or dried thyroid cures this condition. Other methods, such as transplantation of thyroid gland and injection of thyroid juice, have not been of much avail. Until recently the transplantation of thyroid has not been successful, but Christiani and Kummer have succeeded in transplanting fresh, healthy human gland into the tissue about the shoulder, where it has increased and has thus supplanted the deficient thyroid in the neck. It is always wise never to excise completely a thyroid gland, and, if it is necessary to remove the greater part of the tumor, there should always be left behind as large a portion of thyroid as possible.

Post-Operative Tetany or Acute Myxœdema (Tetania Thyreopriva).—The writer has never seen this condition follow operation, and, now that the whole thyroid is so seldom excised, it is a very rare condition.

SYMPTOMS.—The symptoms may appear immediately after operation or they may come on several days later—as late as ten days. There is usually some warning of the attack, such as numbness, nausea, and weakness of the muscles of the arms and calves of the legs, but Chvostek's or Trousseau's signs may be present. Chvostek's sign consists in a rapid contraction of the face following a sharp tap on the facial nerve as it emerges from the parotid gland. In Trousseau's test, which is apt to cause discomfort, pressure on a nerve trunk or artery produces a spasm of the part supplied by that nerve or artery. The attack commences with spasms of the muscles of the calves of the legs and numbness of the face. "The fingers are bent at the metacarpo-phalangeal joint, extended at the terminal joints, pressed close together, and the thumb is contracted in the palm of the hand. The wrist is flexed, the elbows are bent, and the arms are folded across the chest. In the lower limbs the feet are extended and the toes adducted." (Osler.) There may be trismus of the muscles of the face, and this gives rise to pain. The pulse is increased in frequency, but there is rarely any elevation of temperature. In the milder forms the spasms may pass off in a short time, but in the severer cases there may be involvement of the muscles of the throat and back, causing great dyspnœa with cyanosis.

These attacks come on several times a day, and, should the disease last for some time, there will be increase in severity of the spasms; the diaphragm may become involved and respiration cease, or the muscles of the neck may, by their great spasmodic contraction, press on the large veins and cause cyanosis. Unconsciousness comes on and is followed, soon afterward, by the death of the patient. Autopsy reveals no lesions of the nervous system.

It is now a fairly-well-established fact that tetany is produced by removal of the parathyroids.*

Treatment.—In the milder cases, which MacCallum calls "parathyroid insufficiency," the administration of fresh parathyroids from the ox will tend to ameliorate and most probably cure the patient, and will prevent, so long as the treatment is kept up, a return of the spasms. In the more severe forms there is not time to administer one of the organic extracts, and experiment has proved that only by injecting large quantities into the veins of the animal can we stave off the spasms, and that only for a time. Fortunately, the cases seen in the human subject are due, not to the removal of all the parathyroids, but to the removal of only one or two of them, and this limited removal causes the milder form of tetany which is controlled by the administration of the parathyroid of the ox. In operating, therefore, it is very important to leave the parathyroids behind, and this can be done by carefully leaving everything external to the thyroid capsule.

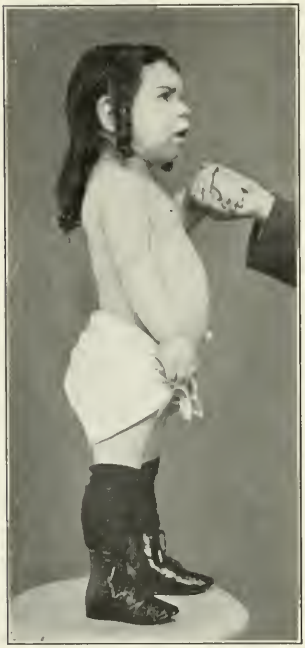

Fig. 284.—Case of Sporadic Cretinism. Age of patient, five years; height, thirty-four inches. (Original.)

Cretinism.—True cretinism is seen only where goitre is endemic. It is said that the parents of cretins almost invariably suffer from goitre or are themselves cretins. There are various forms of cretinism. In some, complete idiocy exists; in others, only disturbance of growth and some want of intelligence exist. Cretins may have complete absence of the thyroid gland or simply a greatly enlarged thyroid. Endemic cretinism is not seen in this country and need not be dwelt on.

Sporadic Cretinism.—This form of cretinism is not infrequently seen. At birth there seems to be very little wrong, but after a time the mother notices that the child is backward and develops slowly; also that the child is dull and stupid, that the lips are thick, that the tongue is too large for the mouth, and that the mouth is kept open. (See Figs. 284 and 285.) Such cases have often at first been treated for tongue-tie, adenoids, etc. The appearance of these infants is quite characteristic. The face is expressionless, the palpebral slit narrow, the forehead wrinkled, the head large for the size of the body, and the temperature subnormal. In sporadic cases no trace can be seen of the thyroid gland, whereas in the endemic cases the individual has an enlarged and diseased thyroid or goitre. As the child becomes older the condition becomes more marked, the nose becomes wide and flattened, the lips thicker and protruding, and the tongue thick and often out of the mouth. The eyelids are thicker and the palpebral slit is narrower. The belly becomes prominent and there is usually an umbilical hernia, and the supraclavicular fat pads are marked. The hair is thin and dry; the teeth are late in appearing and the intelligence is very low; and this diminution in the intelligence may increase from mere dulness to complete imbecility. A child of ten or twelve appears like one of three or four. He will sit about and not attempt to play with his brothers and sisters. Often, at five or six years of age, he is unable to talk or to make himself properly understood, and even later the child can say only a few words.

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*To prevent tetany Charles Mayo and Halsted advise ligating the inferior thyroid close to the thyroid gland, by which measure the cutting off of the blood supply of the parathyroids is avoided. The writer is of opinion that, as isolated portions of thyroid never slough when left behind, the parathyroids would also get sufficient nourishment from capillaries.

Cretins have lived to old age; they are rarely over three or four feet high. An adult cretin has a large head, dry, superabundant skin, short, thick-set limbs, under-developed genital organs, and little pubic or axillary hair. His mental condition does not improve and he takes little interest in anything. He is shy and fond of being alone.

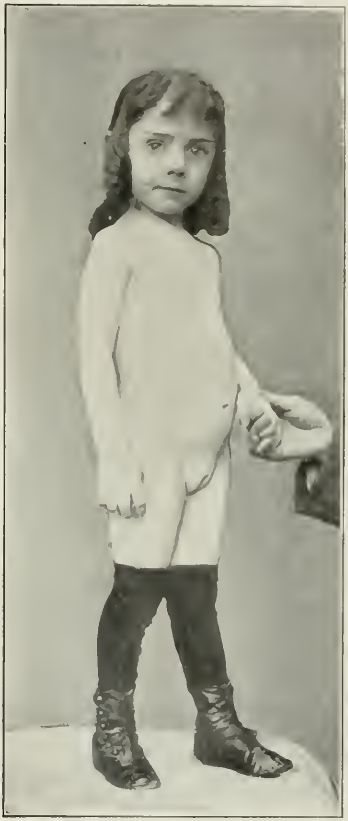

FIG. 285.—Photograph of the Same Patient one Year Later, after Treatment with Thyroid Extract; height, thirty-eight inches. (Original.)

TREATMENT.—The administration of thyroid gland produces miracles in the young cretin, as is seen by the illustrations. (Figs. 284 and 285.) The child becomes intelligent and learns to move about and talk freely; the abdomen becomes less prominent, the hair more natural and abundant, and the expression of the face intelligent: he also begins to grow rapidly. The thyroid gland of the sheep is best, and the fresh raw thyroid is more active and efficient. It is often more convenient to give the dried gland in doses of one grain daily. In young adults, three or four grains may be given three times a day. Should there be tachycardia, giddiness, and headache, the dose should be reduced or given less often. In these cases transplantation of gland tissue has been advised.

II. BRANCHIAL FISTULÆ AND CYSTS OF THE NECK.—FISTULÆ OF THE THYRO-GLOSSAL DUCT.

Branchial Fistulæ.—In the mammalian embryo at the fourth week there are, on each side of the head, behind the oral cavity, four fissures which communicate with the anterior part of the alimentary canal. These are the homologues of the clefts found in branchiate vertebrates. The third and fourth fissures in the human embryo disappear about the sixth week and only the first remains at the end of the ninth week. Sometimes the clefts between these arches persist to a greater or lesser degree, and this explains the occurrence of congenital fistulæ of the neck, as well as that of cysts and diverticula from the œsophagus and larynx.

These fistulæ are lateral or median. If lateral, they are due to incomplete closure of the second branchial cleft; while median fistulæ are due to the persistence of the thyro-glossal duct. It is said that "the position of the external opening bears no relation to the origin of the fistula." All these fistulæ, if complete, open internally in the region of the tonsil—that is, the second branchial cleft. To determine the origin of the fistula one must find the direction of the fistulous tract. If these fistulæ arise from incomplete closure of the second cleft, then they must be below the facial nerve and above the glosso-pharyngeal. Some of the lateral fistulæ open in the median line and must not be confounded with persistent thyro-glossal duct, which runs up the middle of the neck.

The external orifices of these fistulæ vary in position, as mentioned above, but they are always situated internal to the anterior border of the sterno-mastoid. Paget says: "Cervical branchial fistulæ occur as two or three minute orifices on one or both sides of the lower part of the neck, and they lead upward to the œsophagus and larynx, the lowermost being near the sternal end of the clavicle in front of the sterno-mastoid, the next opposite the thyroid cartilage, and the highest between the thyroid cartilage and hyoid bone."

The fistulæ appear as small orifices on the skin, capable of admitting a fine probe. A tag of skin containing cartilage is occasionally seen at the mouth of the orifice. These tags are known as cervical auricles. Many of these fistulæ end as sinuses and others are complete. The usual depth of the sinus is from 2 to 5 cm. When two in number, they often occupy symmetrical positions. They frequently are hereditary and occur in several members of the same family. These fistulæ are lined by mucous membrane and sometimes the epithelium is ciliated, or they may be lined by skin containing sebaceous glands. They secrete a clear mucous fluid. The lumen of the canal varies greatly in different parts; it is usually smaller at the two ends. When complete it may be large enough to allow food to pass from the pharynx.

Occasionally the canal becomes inflamed and there is formed an abscess which causes some difficulty in swallowing. The writer has on two occasions dissected out these fistulous tracts and has found them going up between the two branches of the carotid artery. Watson says that they are located above the superior laryngeal nerve and beneath the digastric muscles. The sinus has been found to contain muscular tissue.

It is probable that many cysts and so-called hydroceles of the neck are due to imperfectly closed branchial clefts.

Sanguineous Cysts.—Sanguineous cysts of the neck probably originate in branchial fistulæ which have communicated with the internal jugular vein. Glueck reports a case where the vein had to be tied before the cyst could be removed. Bland Sutton says that "it has long been suspected that the so-called sebaceous cysts, which arise in the neck below the deep fascia, take origin in unobliterated segments of branchial clefts. Such a cyst need not necessarily contain grease or hair; it may be filled with mucus."

Fistulæ of the Thyro-Glossal Duct.—According to His, the lateral lobes of the thyroid develop separately from the isthmus, which is the lower end of the thyro-glossal duct—"a median, tubular outgrowth from the ventral wall of the embryonic pharynx." (Sutton.) The duct extends from the root of the tongue (foramen cæcum) to the isthmus of the thyroid. The development of the body of the hyoid bone divides the duct into two parts—an upper or lingual, and a lower or thyroid. (Figs. 286 and 287.) Sometimes the persistent duct may pass through the body of the hyoid bone itself.

Usually, as development progresses, these ducts disappear, but occasionally they persist and appear as median cervical fistulæ, lingual dermoids, and accessory thyroids.

Fistulæ.—The fistula, as a rule, is not congenital, but appears later, for it is originally an incomplete internal one that reaches to the neighborhood of the skin. Branchial fistulæ, on the other hand, are always congenital. We are indebted to Marshall for our knowledge of the nature of these fistulæ; he had the opportunity of dissecting a child aged five who died of diphtheria and had a median fistula. The opening of the fistula occurs in the middle line between the suprasternal notch and the hyoid bone, usually just below the cricoid cartilage, and appears as a pin-head-sized opening in a puckered, scar-like depression, which is usually moist. A probe introduced into the opening passes directly upward, in the middle line, to the hyoid bone and immediately beneath the skin. Sometimes the fistula forms a raised ridge externally. In some cases the fistula pierces the body of the hyoid bone or passes behind it through the tongue to the foramen cæcum. Bland Sutton relates a case where a fibrous cord behind the hyoid bone was continuous both with the pyramidal lobe of the thyroid and with the tube leading to the superficial sinus. The fistulæ are lined with cylindrical epithelium, sometimes ciliated, and in the centre there is often squamous epithelium. These fistulæ are probably at first retention cysts which have developed from the persistence of the thyro-glossal duct, and in which the secretion goes on accumulating until they are opened by a surgeon or burst through the skin and form a sinus.

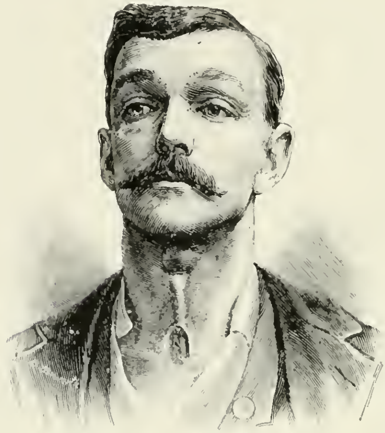

Fig. 286.—Median Cervical Fistula Associated with a Persistent Thyroid Duct. (After Bland-Sutton.)

Lingual Dermoid.—These dermoid cysts appear between the two genio-hyoglossi muscles or project into the submaxillary space and also into the mouth, and they arise from an unobliterated lingual duct. A probe may sometimes be passed through the foramen cæcum down to the space between the two muscles. This is occasionally represented by a solid cord. If part of this duct remains patent while the two ends are closed, the secretion from the mucous surface and sebaceous glands collects and forms a tumor. These cysts are lined with squamous epithelium and often contain hair, sebum, and cholesterin. They are easily enucleated by a vertical median incision in the submaxillary space.

Accessory Thyroids.—These have already been described in another place, but, no doubt, some of these accessory glands have their origin in the thyro-glossal duct. They usually occur in the neighborhood of the hyoid bone and behind the two lobes of the thyroid; they have also been seen in the submaxillary region and at the base of the tongue. When they occur laterally, in a line with the great cornu of the hyoid, they are offshoots from the lateral lobes of the thyroid gland. These accessory thyroids, in cases of goitrous thyroids, may form moderately large tumors which are also goitrous.

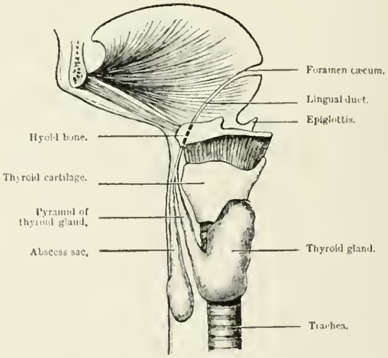

Fig. 287.—Diagram to Show the Relation of Parts in a Case of Median Cervical Fistula. (From Bland-Sutton, after C. F. Marshall.)

Treatment of Neck Fistulæ.—Many methods have been devised for treating these cases. Caustics, electric cautery, and excision are most in vogue. The latter is the best of all and the only sure method of treatment. In branchial fistula total excision of the fistulous tract is the best procedure. All the sinus must be removed, even if part of the tonsil has to be dissected away, for, if a small part of wall is left behind, the fistula is sure to recur. The operation is very difficult and should be undertaken only by experienced surgeons on account of the close relationship between the sinus and the carotid sheath.

Total excision of a median fistula is even more difficult, and, to remove the sinus effectively, the basihyal may have to be cut through.

Injection of caustics, such as silver nitrate, chloride of zinc, carbolic acid, etc., is not without danger and generally ends in failure.

III. THYMUS.

ANATOMY.

The thymus gland varies much in size in different individuals. It is situated chiefly in the thorax, but the upper ends of the two lobes, of which it consists, project to a variable distance into the neck, usually meeting the lower ends of the lateral lobes of the thyroid and being connected with one lobe by a ligament. The gland lies in the superior and anterior mediastinal spaces, behind the sternum; it extends to the level of the fourth costal cartilage, having on each side the pleuræ and lungs, and, behind, the pericardium, great vessels, and trachea. It consists usually of two lateral lobes, pinkish in color and of a soft and pulpy consistence.

Sometimes there is an intermediate lobe, and occasionally the gland forms a single mass. It varies in size in infants, the best nourished having the largest glands. It attains its greatest development toward the end of the second year, when it may measure from 1½ to 2½ inches in length and ¾ to 1½ inches in breadth. It slowly diminishes in size until puberty, when it rapidly undergoes fatty degeneration and almost entirely disappears in adult life, mere remnants being found.

Occasionally the thymus may persist into adult life. This occurs in certain diseases such as exophthalmic goitre, leukæmia, Hodgkin's disease. It is said to persist sometimes in myxœdema and acromegaly.

The function of the gland being unknown, the pathology it still obscure.

DISEASES.

Status Lymphaticus.—According to Paltauf enlargement of the thymus is only part of the clinical picture; in addition, the spleen is enlarged, as are also the thyroid gland and the lymph nodes (especially of the neck and axillæ), the lymphoid tissues in the naso-pharynx and root of the tongue, Peyer's patches, and the glandular tissue of the intestines; and with these conditions is associated hyperplasia of the bone marrow. Status lymphaticus is frequently associated, in children, with rickets and scrofula, and, in adults, with acromegaly and Graves' disease. There may be increased dulness in the upper part of the sternum, and occasionally during forced respiration the thymus may be visible at the suprasternal notch.

Persons with such a diathesis as that described above are liable to fatal syncope. It has been stated that to this cause may be attributed some of the sudden deaths which occur during anæsthesia, as also some of the deaths which occur from syncope during or immediately after bathing. It has been suggested, furthermore, that the defective action of the heart may be due to auto-intoxication caused by thymus internal secretion.

If this status lymphaticus be recognized it should be treated in much the same manner as one would treat a case of scrofula, and care taken to avoid anything likely to cause syncope. When, in a case of chronic dyspnœa, tracheotomy fails to relieve, the possibility of enlarged thymus should be considered, the superior mediastinum opened, and the gland pulled out and partially excised or completely removed.

Anæsthetics are particularly dangerous in this condition, the heart muscle being usually flaccid and there being a lack of tone in the circulatory system. Ether, given by the open method, is advised by McCardie in cases of suspected status lymphaticus, and before the administration of the anæsthetic is commenced a hypodermic of strychnia and atropine should be given.

Tumors.—Tumors of this gland, owing to the very difficult position in which they are situated, are rarely interfered with. Sarcomata are the most common tumors, but they are rarely recognized, being supposed to be enlarged lymph nodes. Malignant lymphoma has been found, as has also carcinoma (arising from the epithelial tissue).

Dubois's abscesses of the thymus, filled with soft, cheesy matter, are probably broken-down gummata, the result of congenital syphilis. Cysts of the thymus, improperly called Dubois's abscesses, have been investigated by Chiari, who regards them as a growth of thymic tissue into the corpuscles of Hassall. Dermoid cysts have also been found in the thymus; they contained hair, epithelium, and fatty contents, as in dermoid cysts of the ovary.

G. N. Acker reports a case of sarcoma of the thymus, where the most conspicuous symptom during life was great œdema of the left side of the face and left arm. This sarcoma involved other parts as well, such as the left lung and left axillary spaces; it exerted pressure upon the subclavian vein. Paviot and Gerest report a case of primary epithelioma of the thymus in a woman aged fifty-two.

Simple Enlargement of the Thymus (Hyperplasia).—This condition may exist in children or adults quite independently of other diseases, and fatal dyspnœa and cardiac failure may be due to it. (Fig. 288.) The enlargement may be acute or chronic.

In acute cases (thymic asthma), the child, apparently in perfect health, chokes, become cyanosed, and dies, the only morbid appearance at post-mortem examination being an enlargement of the thyroid.

In the chronic form the dyspnœa is progressive. Ehrhardt, of Koenigsberg, says that the first operation for enlarged thymus was performed by Rehn and reported by Siegel, in 1896. The patient was a six-years-old child who had suffered from dyspnœa for four weeks. Tracheotomy and the introduction of a long tube relieved the symptoms. Later, when a short cannula was substituted, difficulty of breathing again came on: so the superior mediastinum was opened and immediately the thymus appeared. The gland was pulled out still further and fixed outside the chest, with permanent relief to the patient.

Fritz Koenig, in 1897, made a partial extirpation of the gland in a nine-weeks-old baby after tracheotomy had failed to relieve the dyspnœa. The remaining portion of the gland was pulled out and sewed to the manubrium and the tendon of the sterno-mastoid muscle.

Ehrhardt has performed total extirpation of the thymus in two cases; the first was in a child of two years, the second in a girl of fourteen. No evil results followed complete excision: the voice was not interfered with and the dyspnœa was permanently relieved. The operation is simple. A straight incision is made in the median line from the cricoid cartilage to the episternal notch; the superior mediastinum is opened and immediately the enlarged gland protrudes. It is then pulled out and enucleated with the finger, very few vessels requiring ligature. The procedure is something like the enucleation of a large lymph node. Should the operator wish to remove a part of the gland, this can be done only between two ligatures.

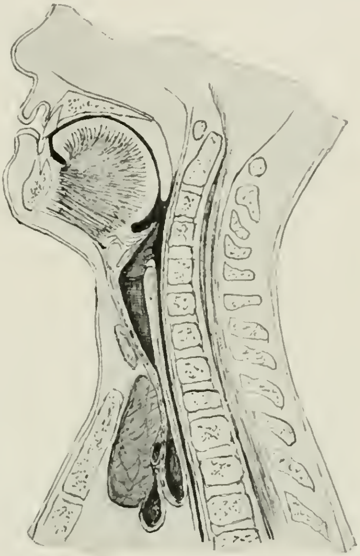
FIG. 288.—Enlargement of the Thymus, Showing Pressure on the Trachea. (Original.)

The dyspnœa is due to pressure on the trachea, and this is much increased when the head suddenly falls or is bent backward, for then the thymus is compressed in the upper opening of the thorax. It is said in some cases that pressure on the pneumogastric nerves causes interference with these functions and results in cardiac dilatation. Pressure on the aorta, leading to dilated heart, is given also as a cause.

Surgery of the Thymus Gland.—J. Schwinn (*Journal of the American Medical Association*, June, 1908) reports a case of thymic asthma in a baby twenty-three days old in which he removed the right half of the thymus *in toto* and part of the left. Being unable to extract the gland through the upper aperture of the chest without producing alarming symptoms of dyspnœa due to compression of the trachea, he split the upper part of the sternum and, forcing the two halves apart, delivered the gland. The patient was discharged cured eight days after operation.

ADDENDA.

Histology of Graves' Disease.—In some cases of marked exophthalmic goitre, the gland, though enlarged, appears to be perfectly normal microscopically, and again in other cases of goitre where there is marked hyperplasia, no symptoms of Graves' disease have shown themselves. However, in every case of death from Graves' disease with or without operation, seen by the writer, there have always been hyperplasia and infolding of the epithelium and also enlargement of the thymus gland.

Thyroidectomy.—Jackson of Pittsburg performed thyroidectomy successfully in two stages, first performing tracheotomy and four weeks later enucleating the gland with his finger.

It is said that rickets in children is due to absence of the thyroid.

Parathyroids.—Vincent and Joly state that when the parathyroids are removed animals do not die, though Gley and MacCallum assert the contrary. Forsyth, one of the latest investigators, holds that the parathyroids are really thyroidal in nature, have no special function, and are really not essential to life. Others assert that when the thyroid is extirpated the parathyroids assume the function of the thyroid and develop vesicles containing colloid matter. Although the writer has extirpated completely over a dozen thyroids and has taken no care to preserve the parathyroids, yet he has never seen a case of tetany nor yet a case of myxœdema except in a patient on whom repeated operations were performed for carcinoma.

SURGERY OF THE THORAX AND SPINAL COLUMN.

*By NORMAN B. CARSON, M.D., St. Louis, Missouri.**

I. WOUNDS, DEFORMITIES, AND DISEASES OF THE THORACIC WALL.

The thorax, which may be described as a cage with movable walls which are capable of expansion and contraction, is made up of cartilaginous and bony parts. The form of the thorax is that of an irregular truncated cone much deeper behind than it is in front and broader from side to side than it is from before backward. The bony elements consist of ribs, sternum, and thoracic vertebræ. The cartilaginous element consists of the costal cartilages. The sternum may always be felt in the middle line in front. The ensiform cartilage is at the lower extremity of the sternum and is overhung on each side by the costal arch. The anterior surface of the thorax on each side is covered by the pectoralis major muscle. The ribs are arranged in twelve pairs. The first seven pairs reach the sternum through their cartilages and are called true ribs (costæ veræ) or sternal ribs. The remaining five pairs of ribs do not reach the sternum and are called false ribs or asternal ribs (costæ spuriæ). The cartilage of each of the three upper asternal ribs joins the cartilage of the rib immediately above it. The last two ribs on each side have their cartilages ending free and are called the floating ribs. The upper ribs are covered by thick muscles and cannot be felt except at their sternal terminations. In order to count the ribs it is best to begin with the second rib which joins the sternum at the junction of the manubrium and the body of the sternum. The twelfth rib is often too small to be palpable. The nipple is usually over the fourth intercostal space; but its position is subject to great variations, particularly in women, and it should never be used as a landmark in counting the ribs.

It is the author's purpose in this section to consider the malformations, the injuries, and the diseases of the thoracic wall, confining his remarks to those conditions which affect the thoracic wall itself but do not involve the viscera contained within the chest cavity. The subject of fractures and dislocations of the bones or cartilages of the thoracic wall will not be considered here, as it has been taken up in the articles on fractures and dislocations.

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*Author's Note: The writer wishes to acknowledge his indebtedness to Dr. Nathaniel Allison, of St. Louis, for valuable aid rendered in the preparation of this article for publication, and to Dr. W. C. Krauss, of Buffalo, N. Y., for the use of an unpublished manuscript on Tumors of the Spinal Cord, from which manuscript he has borrowed a number of data of importance. The author also wishes to express his thanks to the various gentlemen from whose works he has taken illustrations.

WOUNDS OF THE CHEST WALL.

The wounds which involve the thoracic wall may be divided into the following heads:—Contusions, Penetrating and Non-Penetrating Wounds, and Burns. The penetrating wounds of the chest will receive consideration in Vol. VII., in the article on Surgery of the Lungs, etc.

Contusions of the Chest.—Contusion of the chest is an injury which usually results from a blow with a blunt instrument or from some violent pressure. The injury may be limited to the soft parts or it may involve the bony elements, resulting in fracture. It may be severe enough to cause injury to the internal organs, and this at times without damaging the chest wall to any marked extent.

SYMPTOMS.—The symptoms produced by these injuries vary in direct proportion to the severity of the blow or the degree of the pressure. The patient may present a definite picture of shock, and this may be the case where there is little evidence of external injury. The physical signs of injury, which appear more or less quickly, are ecchymoses, hæmatoma, the laceration of muscles, and occasionally emphysema of the subcutaneous tissue. The latter condition may involve only a limited area or it may extend over the entire chest wall, neck, face, and abdomen, so that the normal contour of the individual is altered beyond recognition.

DIAGNOSIS.—The history obtainable from the patient or from those who witnessed the injury will generally make clear the character and the extent of the injury. Hæmatoma is evidenced by the appearance, at the seat of the injury, of a soft tumor that varies in size according to the amount of blood extravasated and the degree to which the density of the tissues interferes with its spread. Where the intercostal arteries have been ruptured, or where the internal mammary artery has been injured, the hemorrhage resulting may be of vital significance. Emphysema may be limited or general. The differential diagnosis between blood clot and a tumor containing air is determined by palpation and by percussion. Palpation reveals crepitation where air is present, especially at the margin of the tumor; percussion over a tumor which contains air gives a resonant note, while the note will be completely flat over a tumor containing blood. The laceration of muscles is evidenced by the impairment of function of the part controlled by the injured muscles, and also by a depression corresponding to the length and breadth of the tear or laceration in the muscular tissue. The presence of emphysema is suggestive of fracture of a rib, though it may exist where no fracture is demonstrable. Careful examination should be made to detect the presence of injury to the organs contained within the thorax.

TREATMENT.—When shock is present to any degree, stimulants, warmth, and absolute rest are the main factors to be observed in treatment. Where there is hæmatoma, applications of evaporating lotions should be made unless the size or tenseness of the tumor seems likely to influence the nutrition of the integument, in which case warm applications and the removal of all pressure should be employed. If, despite this treatment, it becomes evident that gangrene or sloughing of the skin is about to follow, the tumor should be freely incised and the clot of blood removed. If hemorrhage still continues, the bleeding vessel should be picked up and ligated. As a general thing, extravasated blood is absorbed and the tumor disappears spontaneously; in rare cases, however, these hæmatomata become infected. When this happens, free incision should be made, the pus evacuated, and the cavity washed out and treated antiseptically. Emphysema, as a rule, will disappear spontaneously after a few days. Where muscles have been lacerated no special treatment is necessary unless the involved muscle is of importance to function. When this is the case, the ends of the torn muscle should be carefully sutured together and the parts involved should be confined by a bandage until healing shall have taken place.

Non-Penetrating Wounds of the Chest.—Non-penetrating wounds of the chest may be either incised, punctured, contused or lacerated, or even gunshot wounds. Under the head of punctured wounds are included those where the depth of the wound is greater than the diameter of the opening; under that of lacerated or contused wounds should be placed injuries which are inflicted by a blunt instrument and in which the skin is broken and the surrounding area and subjacent tissues are involved.

Incised wounds are inflicted by sharp, cutting instruments, which make a line of incision through some or all of the soft tissues with or without opening the pleural cavity. They are frequently the result of razor cuts and are at times of great extent, encircling almost half the circumference of the thorax or running its entire length in a vertical or diagonal direction. Punctured wounds are caused by a long, sharp-pointed instrument—such as the stiletto, the bayonet, the pitchfork, or a sharpened piece of iron or wood—which enters the tissues and often involves the pleural cavity. A punctured wound of the chest may be caused by falling on a picket fence. The author recalls a case where a man fell on a broken rake handle, and another where a boy fell from a tree, the chest receiving during the fall a punctured wound from a broken branch. Lacerated wounds are inflicted by an instrument which tears the tissues, or by violence which manifests itself in some other manner. This form of injury is the most frequent of the non-penetrating injuries of the chest wall. Contused wounds are inflicted by a blunt instrument or a fall, and are often accompanied by injury to the thoracic viscera. Occasionally such wounds are followed by the development of traumatic pneumonia, in which the clinical signs are frequently unlike those of ordinary lobar pneumonia; the onset, in the former disease, often being insidious in character, with no initial chill. As to the origin of this form of pneumonia, much has been written. Demuth considers these cases as inflammatory infiltrations, lobar blood infiltrations, the fever depending upon absorption of the products of decomposition of the blood. Dumstrey claims that, owing to the injury which it has received, the alveolar epithelium furnishes a place of lowered resistance in which the diplococci of pneumonia may develop.

Symptoms and Diagnosis.—The clinical picture presented in these injuries is characteristic of wounds of this nature. There is usually more or less hemorrhage, and in some cases shock, at times severe, may be present.

The diagnosis depends upon the history of the injury and the appearance presented by the injured region.

Treatment.—Incised wounds, unless made by a dirty instrument, require simple cleansing, suturing, and dressing. In case the instrument producing the wound is known to have been dirty, the latter should be carefully cleaned, drainage should be established, and antiseptic dressings should be applied. In the treatment of punctured wounds the course to be pursued depends also on the nature of the instrument that has inflicted the injury. If the instrument has passed through the clothing, it is usually necessary to enlarge the wound in order to learn, by a careful examination, whether any portions of it or any other foreign bodies have been carried into the tissues. If no foreign substance is found in the wound, it is enough to cleanse the surface and apply an antiseptic dressing. If the object or instrument which caused the injury has been lying in the dust or is covered with dirt, especially if it has been in use about a stable, the wound should be laid open, washed thoroughly, then cauterized with carbolic acid and immediately afterward saturated with alcohol, packed, and finally dressed with antiseptic dressing. At the same time a prophylactic dose of 5 c.c. of antitetanic serum should be administered, and the dose should be repeated on two succeeding days. This treatment should be especially applied where the wound is due to a wad from a blank cartridge. In no case should one fail to put this treatment into effect where there is any reasonable ground for suspecting the presence of the tetanus bacillus. The same treatment should be applied to lacerated and contused wounds except in cases where the appearance of a scar would be objectionable. Here the edges of the wound may be excised and the fresh surfaces brought together by sutures.

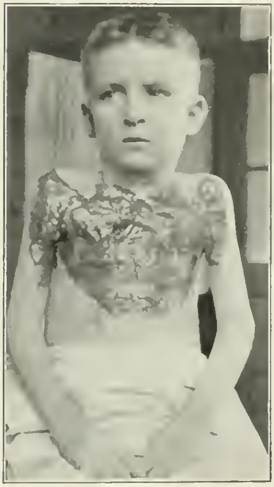

Fig. 289.—Severe Burn of Front of Chest. (City Hospital, St. Louis, Mo.) (See also Fig. 401 on page 627 of Vol. IV.)

Burns of the Chest Wall.—As elsewhere on the surface of the body, burns of the chest wall may be divided according to their severity into burns of the first, the second, and the third degrees. Burns of the chest are comparatively rare, and are usually seen in children who spill hot fluids or corrosive chemicals over themselves. (Fig. 289.) It is to be remarked, as well, that burns of the chest for a given area are more severe in their constitutional effects than are burns elsewhere on the surface of the body. In adult life burns of the chest sometimes follow the explosion of gases or of dynamite or gunpowder. They are sometimes seen in the insane, who are prone to lean against hot stoves or hot steam pipes. Of late years, since the general use of the Roentgen ray, many burns of the thorax have been reported as a result of the use of this light for radiography and therapeutic purposes. Heat from radiation produces, as a rule, a burn of the first or second degree only. A burn of the first degree is evidenced by an erythematous condition of the epidermis and is not a serious affair. A burn of the chest wall of the second degree, in which the Malpighian layer and the papillæ of the skin are destroyed along with the epidermis, may, provided the area involved is of considerable extent, prove a very serious affair. A burn of the third degree (which signifies a complete destruction of the skin and the underlying tissues of the chest, even the muscles at times) is a fatal injury in cases where the area involved is considerable. In such a burn the pleura is in most cases seriously injured. In the more severe cases it will often be noted that all three degrees of burn are present.

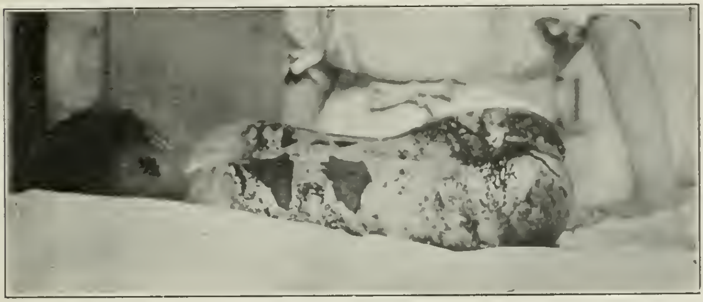

Fig. 290.—Severe Burn of Entire Back and Chest, with Fatal Result. (City Hospital, St. Louis, Mo.)

Treatment.—The treatment of a burn of the chest wall consists of treatment of the general condition of the patient as well as of local treatment at the site of the injury. Burns of the first degree require little treatment for constitutional symptoms; locally, they are best treated by the application of a solution of acetate of lead or of sodium bicarbonate, or by the use of water charged with carbonic acid gas. Where the burn is of a severer degree the author believes that the use of oils should be avoided, as they favor the production of septic conditions and also promote the process of absorption, which is an extremely dangerous factor. Where blisters have formed, the first step is to open them and remove the elevated skin. Some physicians, I am aware, recommend that the skin be allowed to fall back into place, in order that healing may take place beneath it; and, as a matter of fact, healing often does take place when this course is pursued. The application of rubber tissue, covered with a twenty-per-cent solution of boric acid, is in order after the elevated skin has been removed. Picric acid should be used with care on account of the danger of absorption. Exposure to the air should be favored in certain cases. Burns of the third degree are followed by sloughing, the separation of the slough requiring about a week for its accomplishment. As soon as the congestive stage is over, the patient should be brought under the influence of an anaesthetic and the necrotic tissues removed, the denuded area then being treated by the application of boric-acid solution, as stated above. The healing of large granulating surfaces may be aided by skin grafting, in accordance with the method of Thiersch, or by transplanting large skin-flaps from the arm or from other individuals. If the healing eschar involves the axillary region, serious limitation of motion is liable to follow, and a secondary operation will be required to establish function at the shoulder joint. Profound burns of the chest, however, may be recovered from without marked deformity. It is to be borne in mind, nevertheless, that old scars are often the seat of development of carcinoma. Burns caused by the Roentgen ray should be treated in the same manner as are burns produced by other causes. They seem especially liable to the development of carcinoma. The constitutional treatment employed for burns of the thoracic wall is the same as that ordinarily employed in combating collapse and severe surgical shock. Normal salt solution should be infused and the patient's pulse and respiration should be carefully watched. It should be borne in mind that serothorax and pyothorax at times develop as a result of burns of the thoracic wall and require aspiration.

DEFORMITIES OF THE CHEST WALL.

Thoracic deformities may be either congenital or acquired. They are comparatively infrequent.

The congenital deformities of the thorax are usually the result of conditions brought about by defective growth *in utero*. Of these the most important are: sternal clefts, sternal fissures, and hiatus in the sternum. The interest of these deformities consists chiefly in the fact that they may be mistaken for injuries to the chest wall. The sternum may, in some cases, be entirely absent, and a hernia of the lungs is then likely to occur. Again, there may be a partial development of the sternum, with free ribs on the affected side and the intervening space filled with a membrane which bulges during expiration and retracts during inspiration. Through this defect pulsation of the heart or aorta may be felt.

The acquired deformities of the chest are usually the result of pathological conditions, chief among which is rickets.

Flat Chest.—Flat chest is an acquired deformity of the thorax, which is developed by certain occupations and is seen chiefly among those who are required constantly to stoop while at work—shoemakers, embroidery makers, etc. The deformity consists of a sinking-in of one side of the chest at the level of the xiphoid process. It is usually accompanied by the deformity known as "round back," the chest not being actually flattened but appearing so because the shoulders and scapulæ are displaced forward. Hutchinson* has called attention to the fact that these chests are usually round in that they are deeper than normal

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* Hutchinson: Jour. Amer. Med. Assoc., Sept. 11th, 1897.

—a persistence of the fœtal type. He gives us an index which shows the relative depths of the chest at different ages. This index is found by dividing the antero-posterior diameter at the nipples by the transverse diameter at the same level.

Flat chest is often simply an exaggeration of that condition of the chest which is observed in a patient with round shoulders or with kyphosis.

Pigeon Breast.—Pigeon breast (pectus carinatum) is a type of chest which resembles the chest of the quadruped. It is characterized by the projection of the sternum and cartilages in the form of a keel. The lateral diameter is much diminished and the antero-posterior diameter is increased. This deformity is always acquired and may result from rickets, Pott's disease, paralytic conditions, or obstruction of respiration, possibly due to enlarged tonsils or adenoids. (Fig. 291.) It is a deformity which is frequently associated with Pott's disease.

Funnel Chest.—Funnel chest (pectus excavatum) is a deformity of the thorax, the reverse of pigeon breast. The lateral diameter of the thorax is increased and the sternum is displaced. It is, in the milder degrees, a common deformity, and may be of congenital origin.

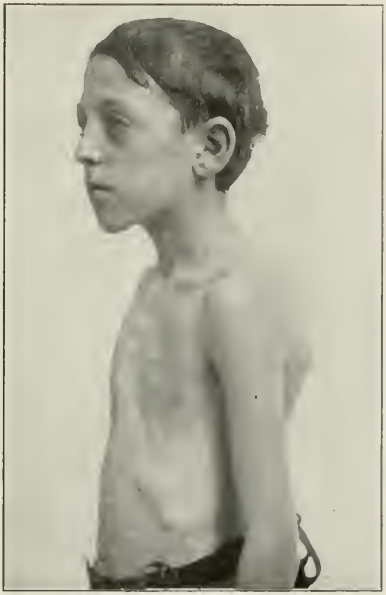

FIG. 291.—Acquired Deformity of the Thoracic Wall, due to Adenoids. Case presents marked caving-in of the left thoracic wall. (Original.)

The acquired deformities of the chest that result from nasal obstruction, or any obstruction to respiration, are very common. Adenoid tumors, according to Young, almost invariably cause a deformity of the chest. Hypertrophy of the tonsils has been assumed by Dupuytren, Cooper, and Warren as an important etiological factor. It may be said that any obstruction of one of the upper air passages, which is great enough to cause insufficient respiratory action during infancy and childhood, will produce thoracic deformity, inasmuch as the chest cannot, under these circumstances, expand normally. Deformities of the chest may also result from paralytic affections which produce insufficient muscular action.

PROGNOSIS.—The prognosis of congenital or acquired deformities of the chest depends upon the nature and extent of the deformity. In fissures of the sternum, or in cases where this bone is absent, a protrusion of the thoracic viscera (pulmonal hernia, pneumatocele) may take place and thus complicate the original condition. After adult life is reached very little can be done to overcome these deformities, certain varieties of which have a serious effect upon the heart and lungs and the process of respiration, and thus indirectly upon the general health and nutrition of the patient.

TREATMENT.—The treatment of congenital and acquired deformities of the thorax consists pre-eminently in removing the cause of the deformity. Cases dependent upon rickets should be treated for rickets and, where there is obstruction to the respiratory organs, this should be carefully and speedily removed. Gymnastic exercises and active and passive movements, coupled with corrective appliances, should be employed. Where there exists an ectopic condition, the defect may be remedied by an osteoplastic operation such as that described by Vulpius. This operation consists in bisecting, longitudinally, that portion of the rib which is immediately adjacent to the gap and connecting each of the separate portions (or flaps), after mobilizing them, with the nearest rib.

Deformities of the Ribs.—Defective formation and entire absence of ribs are uncommon abnormalities. They are usually found to be associated with lateral curvature of the spine.

Cervical Ribs.—Cervical ribs are probably much more frequent than is supposed. Of recent years they have often been discovered by the *x*-ray in individuals in whom their presence had not previously been suspected. Reisman* has reported forty-six cases; Pilling mentions one hundred and twenty-nine cases. (For further details relating to cervical ribs, consult the article on "Surgical Diseases and Wounds of the Neck" in the earlier part of this volume.)

DISEASES OF THE CHEST WALL.

Furuncles and Carbuncles.—The skin which covers the chest wall is provided with an abundance of sebaceous glands, and consequently it is a favorite seat for the localization of furuncles and carbuncles. This is particularly true of the back, where the region of the shoulder blades and root of the neck is exposed to the irritation of clothing and is frequently the seat of comedones and of acne.

The ordinary furuncle will yield rapidly to incision and antiseptic treatment; the carbuncle, on the other hand, is a much more difficult disease to deal with, especially in the aged and in patients who have diabetes. Death from sepsis or from cachexia is not an unusual event in such patients when they are affected with carbuncle. In all cases of furunculosis or carbunculosis the presence of nephritis or diabetes or other constitutional affection should call for careful consideration.

As regards the surgical measures which experience has shown to be effective, the choice lies between crucial incisions and excision of the entire carbuncle; and there is very little doubt to-day that excision is the safer course to adopt. (See also Vol. II., page 307.) Where a diagnosis of diabetes or nephritis has been made, one should be careful to give a very guarded prognosis.

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* Reisman, in University of Pennsylvania Bulletin, March, 1904.

Phlegmon of the Chest Wall.—Acute abscesses of the chest wall arise from infections introduced from without; they also develop as a sequence of the lodgment of a foreign body in a wound; but their most frequent mode of development is from suppurating lymph nodes of the axilla. Here the collection of pus may gravitate along the course of the ribs and point somewhere on the anterior surface of the chest. In making a diagnosis of abscess of the chest wall, it is well to bear in mind the condition known as *empyema necessitatis*,* which is always accompanied by the physical signs of empyema (as may be demonstrated by percussion, auscultation, and exploratory aspiration). Cold abscesses of the chest usually follow a tuberculous periostitis and are at times discovered at some distance from the focus of carious bone.

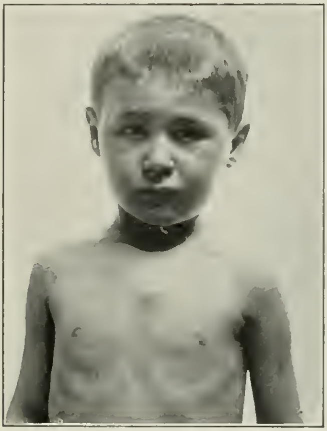

Fig. 292

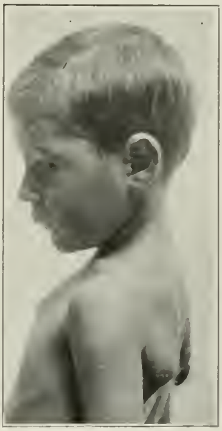

Fig. 293.

Figs. 292 and 293. Front and Side Views of a Patient Affected with Tuberculosis of the Sternum at the Junction of the Manubrium and Gladiolus. In this case the lesion simulated fracture of the sternum so closely that several unsuccessful attempts were made to reduce the deformity before it became evident that the bone was not fractured but diseased (Author's case.)

The symptoms produced by a large abscess of the chest wall are at times very severe. The treatment indicated for any of these conditions consists of drainage, curettage, and antiseptic packing and dressing.

Osteomyelitis of the Sternum and Ribs.—Acute osteomyelitis of the sternum and ribs is a rare affection and it is usually discovered in cases which have foci of osteomyelitis elsewhere. It has been noted that this affection is sometimes associated with typhoid fever and also with syphilis. The region of the rib chiefly affected is at the line of junction between bone and cartilage, or, when the focus is situated in the sternum, it lies at the junction of rib, cartilage, and sternum.

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*"An empyema in which the pus burrows through the intercostal spaces and appears as a subcutaneous tumor." (Gould.)

The treatment is surgical. What is needed, as a rule, is a free and early incision. In a few cases, however, a resection of the diseased area of the bone or cartilage will have to be made.

Tuberculosis of the Sternum and Ribs.—Tuberculosis of the sternum and ribs is more frequently encountered than acute osteomyelitic disease. As compared with tuberculosis of the bones of the extremities, it is a very rare affection. (Figs. 292, 293, and 294.) For a complete consideration of the subject reference should be made to the article on "Tuberculosis of the Bones and Joints," in Vol. III.

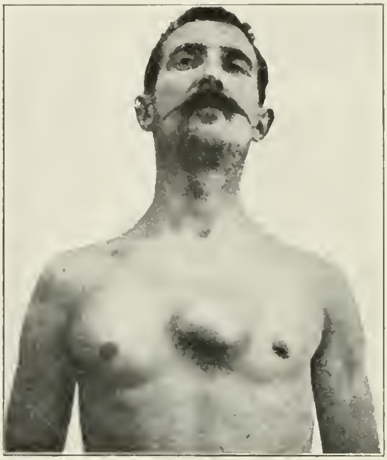

FIG. 294. Tuberculous Disease of the Manubrium Sterni. (From de Quervain's "Spezielle Chirurgische Diagnostik," Leipzig, 1907.)

The patient gave a history of tuberculosis in his family. No evidence whatever of syphilis was discovered. The pus obtained by puncturing the swelling was of a brownish color, tough and mucoid in character. The administration of potassium iodide, which was tried at the very beginning, produced no beneficial effects. Inoculation of a guinea-pig demonstrated the tuberculous nature of the disease.

Syphilis of the Sternum and Ribs.—This affection is very similar to tuberculosis in its clinical aspects. At times the sternum may show extensive destruction, or there may be gummatous swellings on its anterior surface or on the surfaces of the ribs. The diagnosis depends upon the history of syphilis and the presence of syphilitic lesions elsewhere. Treatment consists in the routine administration of constitutional remedies. At times surgical interference for the purpose of drainage may be found necessary.

Actinomycosis of the Chest Wall.—Actinomycosis of the chest wall is seldom if ever a primary infection. Usually it extends from a focus in the neck, face, or vertebra, and involves the clavicle, the sternum, or the ribs. The disease, however, may extend outward from the lungs or pleura. Hickens found the lungs involved in from twelve to fifteen per cent of the cases.

Actinomycosis is characterized by persistent and rapid progress. Following the development of an abscess at the original seat of infection, fistulous tracks form in all directions and establish new abscesses in the surrounding tissues. This burrowing goes on without cessation and the patient presents a picture similar to that of rapidly progressive tuberculosis. Hodenpyl collected thirty-four cases, and of this number thirty-two ended in death. No accurate or certain diagnosis can be made without a microscopical examination of the pus removed from the area involved, and one should never postpone such an examination where the presence of actinomyces is suspected.

The treatment consists in opening the abscesses, washing them out freely with hydrogen dioxide, and then applying a saturated solution of silver nitrate, a ninety-five-per-cent solution of carbolic acid, or, as recommended by Beran, a strong solution of sulphate of copper. The patient should be surrounded by the best hygienic conditions possible and should be given half a grain of sulphate of copper three times a day or potassium iodide in full doses. When new abscesses form, they should be treated as above outlined. (See also Vol. III., page 458.)

Echinococcus of the Chest Wall.—Echinococcus of the chest wall is rare. The literature contains but one case of primary echinococcus of the sternum, viz., that reported by Madelung. This form of cyst develops in the chest wall usually as a soft tumor mass similar to a lipoma, and is generally found in the muscle layer. Diagnosis is made by exploratory incision or puncture, and by the discovery of the hooklets in the fluid contained within the cyst. The finding of the hooklets is at times difficult and even impossible; the presence of succinic acid in the fluid is regarded as a positive diagnostic sign.

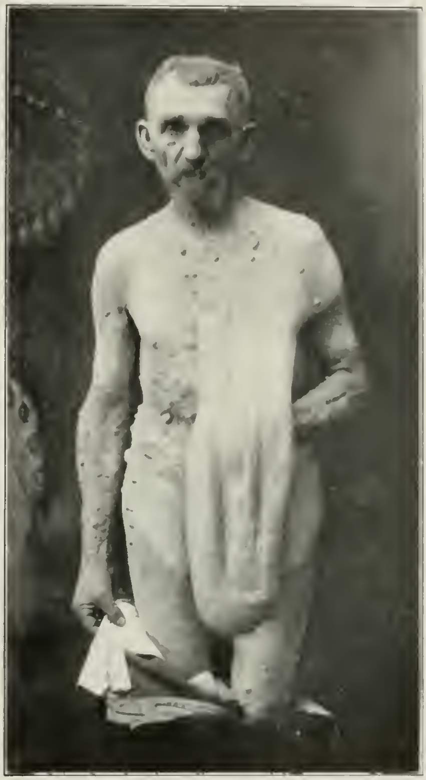

Fig. 295.—Pendulous Tumor of the Breast, and Fibroma Molluscum of the Arms, Chest, Abdomen, and Thighs. (Case of Dr. C. Winfield Perkins, Princeton, N. J. See report in *Medical Record*, Sept. 26th, 1908.)

Exposure of the cyst wall by incision and removal of the entire cyst constitute the only treatment that is required. Prolonged suppuration is apt to follow an operation for the removal of an echinococcus cyst.

New-Growths of the Chest Wall.—As in the case of tumors elsewhere on the surface of the body, the new-growths which involve the thoracic wall may be divided into benign growths and malignant growths. When their origin is taken into consideration they may be separated into those which arise from the soft parts and those which arise from the bones or periosteum.

Benign Growths.—Among the benign growths which are found on the chest wall, mention should be made of sebaceous cysts and dermoids, both of which are usually located on the back. Lipoma is also most frequently found in the tis-

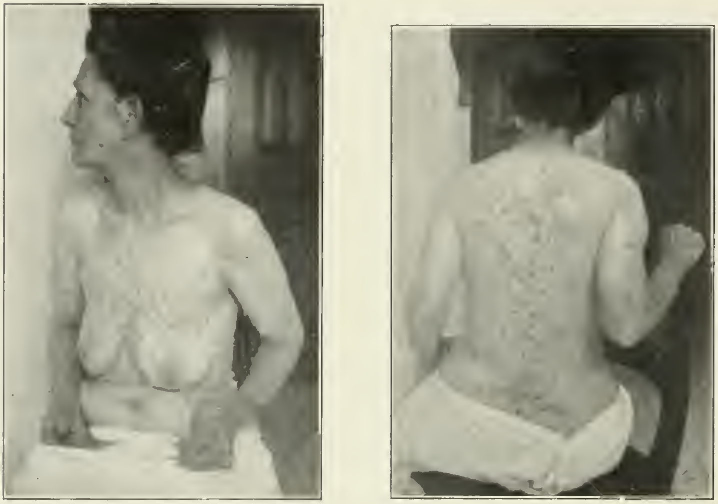

Fig. 296. Fig. 297.

Figs. 296 and 297.—Fibroma Molluscum of the Skin of the Chest and of the Chest Wall. (Author's case.) Fig. 296, front view; Fig. 297, view of the back.

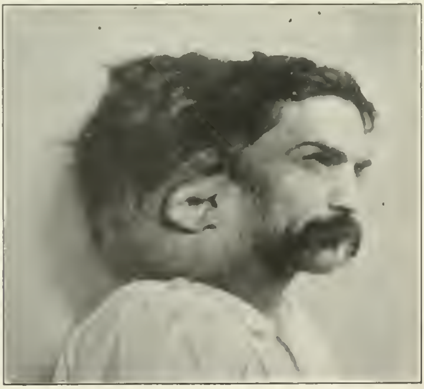

Fig. 298.—Large Fibroma Molluscum of the Neck and Scalp Associated with the Same Lesion of the Chest Wall. In this case the patient is a son of the woman pictured in Figs. 296 and 297. (Author's case.) The tumor underwent sarcomatous degeneration and resulted fatally after the development of a large traumatic hæmatoma and gangrene of the skin covering it.

sues of the back. Fatty tumors are usually lobulated and easy of recognition; they may attain a remarkably large size. The symptoms produced by a tumor of this nature are usually only those which result from mechanical interference with muscular action, due to the size of the growth.

Excision of the growth, which usually entails little difficulty, constitutes the proper treatment.

Fibroma occurs almost as frequently on the chest wall as does lipoma. It is distinguished from the latter by its firm consistency and its slow growth. It usually arises from the submuscular fibrous tissues and is of slow growth, reaching the size of a hen's egg as the maximum. Fibroma molluscum (Figs. 295, 296, 297, and 298) is a form of fibroma which originates from the sheaths of the nerves, directly under the skin. In consistency this tumor is soft. It always occurs in multiple form and the individual tumors may appear thickly scattered over the entire surface of the trunk.

The treatment of fibromata is best carried out by simple incision and removal of the tumor mass. Fibromata which involve the pleura require an exsection of a portion of this membrane, which is a serious procedure. The individual tumors of fibroma molluscum may be removed from the surface of the body with scissors, without the aid of an anæsthetic.

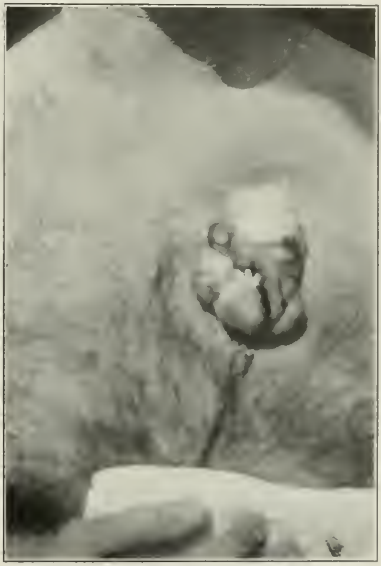

FIG. 299.—Sarcoma of the Chest Wall for which an Extensive Excision of Ribs, Sternum, and Pleura was Done. The condition returned in the form of a widespread sarcomatosis and resulted fatally. (Author's case.)

Enchondroma may arise from the surface of either the sternum or the ribs. Though histologically a benign growth, it is to be remembered that it has a tendency to metastasis. It is a comparatively rare growth on the chest wall and usually develops at the line of junction between bone and cartilage. Enchondromata have a tendency to undergo degeneration and appear as cysts; they may increase in size, involving several ribs and perforating the pleura.

When the tumor is of small size the symptoms are slight; but when the growth increases it may produce marked symptoms of pressure.

Removal of the tumor in its entirety at as early a date as possible constitutes the proper treatment. At times it is necessary to exsect considerable portions of several ribs. It should be kept in mind that pneumothorax and pyothorax are conditions which may follow operations involving the pleura.

Keloid of the skin covering the chest wall may develop either spontaneously or as a secondary manifestation in the scar of a definite injury. The spontaneous variety of keloid is now considered to be indistinguishable from the keloid that develops in a scar. Wilms has shown that an injury to the cutis, with subsequent scar formation, always precedes the development of a keloid. Multiple keloids of the back develop at the seats of former acne pustules. These growths rarely give rise to symptoms, and surgical treatment of them should be avoided.

Nævus, cavernous hæmangioma, and lymphangioma occur on the chest wall. Nævi usually are of no clinical importance. Hæmangioma and lymphangioma may increase to considerable size and may look like large cystic tumors. Where they cause symptoms which demand treatment, it is best to attempt a radical excision rather than to waste time employing puncture, cauterization, etc., for their relief.

Malignant Growths.—The malignant growths which involve the chest wall are sarcomata and carcinomata.

Sarcoma.—Sarcoma of the chest wall has been reported as a primary growth. As a rule, however, it is secondary to sarcoma situated elsewhere,—as, *e.g.*, in the breast, the mediastinum, or the thoracic viscera. Primary sarcoma of the sternum has been more frequently observed. The sarcomata which arise from the bones may be divided into two classes: osteosarcomata and chondrosarcomata. They usually occur before middle life. They grow slowly, as a rule are painless, and have a marked tendency to early metastasis. Sarcoma of the sternum, involving the upper end, has been removed successfully. Sarcoma of the chest wall, wherever it occurs, is a very serious condition and one requiring prompt surgical interference if a cure is to be hoped for. The size of the sarcoma is often very much greater than the external appearance of the tumor would incline the surgeon to believe. (Figs. 299, 300, 301, 302, and 303.)

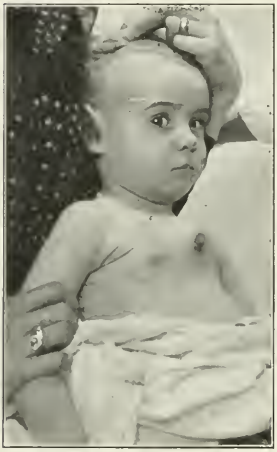
FIG. 300.—Osteosarcoma of Sternum and Ribs. (Author's case.)

The surgical treatment of sarcoma of the chest wall consists of as thorough an excision of the growth, and of the involved structures near the growth, as is possible. It is to be borne in mind that death usually follows the appearance of this growth on the chest wall, no matter how complete the surgical treatment may have been. Coley's serum may perhaps afford some relief in these cases. (See Vol. III., page 454.)

Carcinoma.—Carcinoma of the chest wall may be primary, and when such is the case the growth is usually of the rodent-ulcer type. Early treatment with the x-ray has been successful in these early cases. When the tumor has reached a later stage of development a thorough exsection should be done. Secondary carcinoma of the chest wall may follow from disease in the mediastinum or from cancer of the breast. In the latter case it often attains considerable size, spreads rapidly, and involves the ribs and pleura. The prognosis, where the growth is confined to the skin, is more favorable than when the disease is of sarcomatous nature, as there is less tendency to metastatic spreading. Where the growth is secondary to carcinoma in some more distant part of the body, and where it has attained considerable headway before treatment is established, the prognosis is absolutely hopeless.

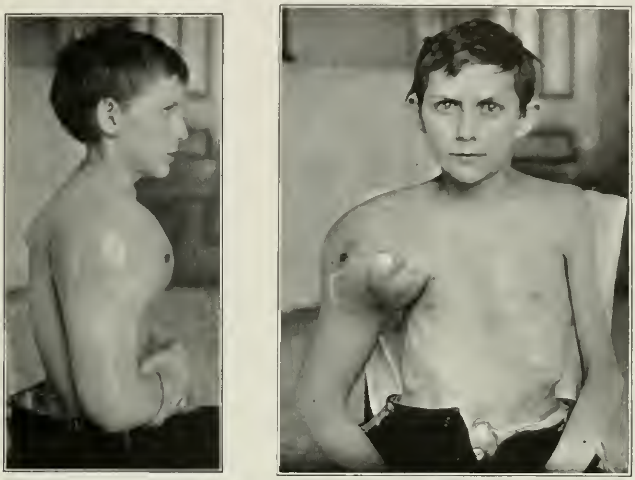

Fig. 301. Fig. 302.

Figs. 301 and 302.—Side and Front Views of a Patient Affected with Osteosarcoma of the Chest Wall, with involvement of the bones at the shoulder-joint. (Author's case.)

Treatment consists in as thorough an excision of the growth as is possible.

Hodgkin's Disease may be accompanied by characteristic manifestations in the thoracic wall, the swelling of the lymph nodes in the axillæ simulating sarcoma in their appearance.

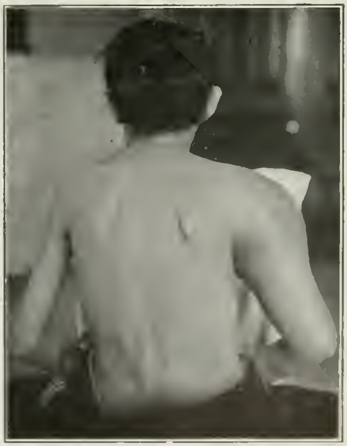

Fig. 303.—Back View of the Same Patient. (See Figs. 301 and 302.)

Diseases of the Clavicle.

The clavicle is subject to the same diseases as are the other bones of the skeleton, though to a remarkably less degree. Osteomyelitis, for instance, affects the long bones with much greater frequency than the short ones. In the statistics accumulated by Froehner, the long bones were diseased four hundred and seventy times and the short and flat bones thirty-four times, eight of the latter being cases of disease of the clavicle. When acute osteomyelitis affects the clavicle, it may produce extensive or complete necrosis. Acute epiphysitis is also at times localized in the clavicle.

Syphilis of the Clavicle. Syphilis, either hereditary or acquired, frequently manifests itself in the clavicle, the external end being the part usually affected, and the growth appearing as a gummatous prominence or as tophi which may break down and suppurate. The rapid growth of such a lesion may cause it to be mistaken for sarcoma.

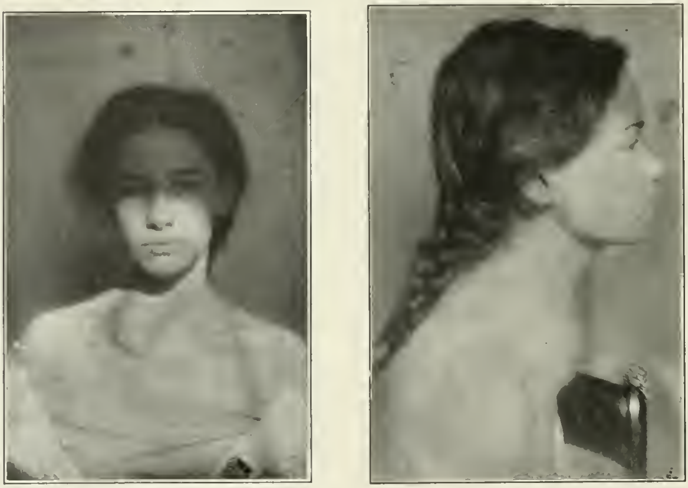

Fig. 304. Fig. 305.

Figs. 304 and 305.—Front and Side Views of a Patient Affected with Sarcoma of the Clavicle. (Author's case; details given in the text.)

Tuberculosis of the Clavicle.—Tuberculosis of the clavicle is very rare, and when it does occur it usually affects the sternal end. Tuberculous involvement of the joints at either end of the clavicle has been rather frequently reported.

New-Growths of the Clavicle.—New-growths of the clavicle are rare and are usually osteosarcomata, although osteomata and chondromata have been reported. (See Vol. III., p. 459.)

TREATMENT.—The treatment for simple necrosis or osteitis of the clavicle consists in total or partial excision of the bone. Where the disease is due to tuberculous involvement, curetting and drainage will often effect a cure. For syphilitic gummatous degeneration, total or partial excision should be employed. The following case history, courteously furnished by Dr. M. G. Seelig, may here be cited:—

Male patient, aged 36; twelve years previously he contracted syphilis. This was "cured," and he married. He has one child five years old, perfectly healthy; has been perfectly well himself except for "French trouble" which dates back three and one-half years, when he first noticed a thickening of the right clavicle. This has gradually increased. Six weeks ago pain began and an ulcer the size of a dime formed, discharging pus. Physical examination shows nothing abnormal aside from the condition of the right clavicle. Inner half is swollen to the size of a hen's egg. A small opening on anterior aspect leads into a sinus one inch and a half deep, directed outwardly. Probe impinges upon dead bone. Operation:—Incision four inches long directly over clavicle. Inner one-sixth of bone found necrotic, mostly on posterior surface. A piece, two and one-half inches long, removed from sternal end of clavicle. Recovery uninterrupted. Six weeks after operation patient moves arm without difficulty.

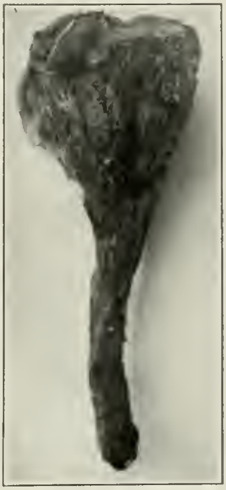

FIG. 306.—Sarcoma of the Clavicle. Entire clavicle and tumor excised in case shown in Figs. 304 and 305.

There seems to be some doubt as to who is to be credited with the honor of having first excised the entire clavicle. Treves* gives McCreery of Kentucky (1811) the credit of having first removed this bone in its entirety, while Gross† says that Remmer was the first to excise the clavicle in 1732. Rudolph Zabel‡ says the oldest known total extirpation of the clavicle was done by Moreau and d'Angerville, of Paris, in 1765, and that the operation by Remmer, which by most authors is considered the oldest, was without doubt not a total but only a partial extirpation. O. Heyfelder§ gives credit to Meyer for total (1823) and to Cassebohm for partial extirpation (1710). A careful consideration of the literature leads me to conclude that Zabel is correct, and that Moreau and d'Angerville were the first to perform total extirpation of the clavicle.

The removal of the clavicle in part or entirely has been done for caries and necrosis, for morbid growths, and for displacements which have resulted from disease. Gross* says that Mr. Davie, many years ago, excised the inner extremity of the clavicle, in a case of dislocation backward from deformity of the spine. The head of the luxated bone in this case caused such a degree of pressure on the œsophagus as to endanger life by inanition.

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* Treves: "Operative Surgery," vol. i., p. 638.

† Gross: "System of Surgery," vol. ii., p. 1077.

‡ Zabel: "Zur Casuistik d. Total-Extirp. d. Clavicle."

§ Heyfelder: "Lehrbuch d. Resection," 1853, p. 300.

The transactions of the London Pathological Society record the removal, post mortem, of a few examples of sarcoma of the clavicle. In one instance the growth produced death, within seven weeks after its known commencement, by pressure on the trachea.

The Operation of Excision of the Clavicle.—The operation of excising the clavicle, either in part or entirely, on account of caries or necrosis, has been found by the writer to offer no special difficulties, and yet a few authors consider it quite a serious operation. On several occasions he has removed a fairly large part of this bone after simply enlarging the already existing opening and lifting the diseased fragments from their bed. On the other hand, he considers the excision of the clavicle for morbid growths an operation of the most serious character, both on account of the immediate and also on account of the ultimate dangers. Velpeau† calls the operation a daring attempt never carried into effect except in a few cases of operation upon the shoulder. "Yet," he adds, "there are circumstances sufficiently numerous which require this operation if we wish not to abandon the sufferers to certain death."

Gross,‡ in speaking of the difficulties presented by the two operations, the one for necrosis and the other for tumors, says: "But the case is widely different where the clavicle is buried in a large mass of disease, when the circumjacent structures are all intimately matted together by morbid deposits, and where not only the great vessels of the neck but likewise the principal nerves and thoracic duct are in close proximity to the affected bone, as in the case of Mott,§ which required over forty ligatures and four hours for its completion. Under such circumstances the operation must be of extraordinary difficulty, demanding the greatest patience, skill, and anatomical knowledge for its successful execution."

While I can appreciate the difficulties that may be encountered in certain exceptional cases, I was much surprised at the ease with which the operation was accomplished in the case of which I shall give a brief account farther on, and yet the tumor, in this case, was of large size and involved the sternal end. A study of the literature of the subject has led me to believe that the dangers are more imaginary than real, and that the operation, with ordinary care and with a thorough knowledge of the anatomy of the region, should be one of very small mortality. I find, for example, records of forty-nine well-authenticated cases of removal of the clavicle, in part or entirely, for tumors, simple or malignant, with forty-two recoveries and seven deaths—a mortality of sixteen per cent. Of these operations, forty were for osteosarcoma and four for carcinoma; in three, the tumor removed was of a simple or non-malignant nature; and in one the character of the growth was not given. Delatour* has collected forty cases, with a death rate of eighteen per cent, and Barling† twenty-four cases of which number six died within five weeks; but in two of them death cannot be attributed to the operation, as one died of brain tumor and the other from hæmatemesis. Barling thinks that this rate (sixteen per cent) may be unduly low, as probably some of the unsuccessful cases were not reported. Of the eighteen patients who recovered, he has been able to trace only twelve, and some of those but for a short time. Five were either dead or dying of recurrence within twelve months after excision; four were well at periods varying from three to twelve months after operation; and, of the three remaining patients, one was alive three years and another ten years after the operation, while the third one (Mott's case) remained well fifty-four years.

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* Gross: "System of Surgery."

† Velpeau, translated by Rouse, London, March 23d, 1889, vol. i., p. 575.

‡ Gross, "Operative Surgery," 1835, 1st ed.

§ Mott, in Gross' "System of Surgery," vol. ii., p. 1040.

Of the forty-nine cases which I have collected, the records were obtained in eighteen, including Barling's three cases. Of these, nine survived the operation for periods varying from two to fifty-four years, eight died from a return of the disease in from eleven days to five months, and one died within three months, from fracture of the skull.

From a study of the reports of cases one is impressed with the fact that it is exceedingly difficult, if not impossible, to arrive at any satisfactory conclusion as to the results obtainable from operative interference; and the question suggests itself whether, in view of the high mortality, the operation is justifiable. Barling‡ says: "In estimating the degree of malignancy of these growths of the clavicle, one is hampered by the absence of exact information as to the nature of the tumor and as to whether it arises from the periosteum or the medulla of the bone. I think, however, that the details I have related are sufficient to show that the immediate mortality of the excision of the clavicle for growths is not so great as might have been anticipated, and that the prognosis as to recurrence and dissemination is better than it is after amputation for sarcoma of the bones of the lower extremities." (See also Vol. IV., page 402.)

It is remarkable how little deformity follows in cases of recovery from the operation, how little impairment of function results, and how rapidly function is restored. In Travers' case "the boy had complete power over his arm in all directions, and, only a few months after the operation, was amusing himself by rowing on the Thames." Jesset's§ case "eleven weeks after the operation had perfect motion of the arm in every direction, being able to play the piano, dress her hair," etc. In Britton's case, a coal-heaver, the patient "was able to use his pick as well as ever, and could carry heavy weights on the shoulder from which the clavicle had been excised, while on the sound side he had no such power." Caddy,‖ speaking of the result in his case, says: "The movements were perfect, and, being a well-drilled man, he took care that his right shoulder should never drop, so that when clothed no one could notice any difference in the two shoulders. This was probably due to the fact that, the outer third of the clavicle being left behind, the clavicular attachments of the trapezius and the deltoid muscles were not interfered with." In my case the patient could move the arm more or less freely when she left the hospital, but it was then too soon to determine what would be the result as to restoration of function.

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* Delatour, in Annals of Surgery, 1903, vol. xxxvii.

† Barling, in British Medical Journal, March 15th, 1890, p. 598.

‡ Barling, in British Medical Journal, March 15th, 1890, p. 598.

§ Jesset, in London Lancet, June 8th, 1889, p. 1128.

‖ Caddy, in New York Medical Record, Nov. 19th, 1892, p. 587.

The patient, a young woman aged 18 years, came under my care in the hospital on February 2d, 1904, giving the following history:—

No hereditary disease in the family known; habits good; had usual diseases of childhood without bad results; was never very strong or healthy. Last July, after an attack of measles, she felt pains at the sternal end and along the sterno-cleido-mastoid muscle on the right side. About two weeks later she noticed some enlargement. The part continued to be painful, with occasional sharp, shooting pains. The tumor increased slowly until about two months before she came to the hospital. It then commenced to increase rapidly, and when I saw her the growth involved nearly one-half of the clavicle and stood 5 cm. above the surface; it measured 10 cm. in length (horizontally) and 9.5 cm. in its vertical and oblique diameters.

Physical examination revealed nothing abnormal. Urine normal. Blood count: white corpuscles, 7,440; red, 4,160,000; hæmoglobin, 45 per cent.

The operation was done on February 8th, and required forty minutes; one ligature was applied. The patient made a good recovery and left for home on February 20th.*

Deformities of the Clavicle.—Congenital defects in the clavicle, though rare, occur at times. Klar† has described thirty-nine cases in which there existed defective development of the clavicle on one or both sides. In the majority of his cases a portion of the clavicle existed at the sternal extremity of that bone. The absence or presence of the clavicle seems to cause slight inconvenience, though in some of his cases it was accompanied by kyphosis or round back, and in others there existed the ability to bring the shoulders in apposition in front.

Surgery of the Male Breast.

From personal experience and from a study of the literature of this subject the author is led to believe that it deserves more attention than is generally awarded to it in the text-books. The anatomy of the male breast differs somewhat from that of the female organ. Spalteholtz describes it as a small flat mass consisting mainly of connective tissue, with only traces of gland structure. It possesses an areola and mammary papillæ of a brownish color, the latter being somewhat smaller than those found in the female. The papillæ are generally situated over the fourth intercostal space, less often over the fourth or fifth rib. Frequently the right and left breasts are at different heights and at different distances from the median line. The male breast is usually a small flattened mass, more triangular in shape than round, and enveloped by a membrane which entirely surrounds it and which has its origin in the sternum. The upper border of this membrane contains a ligamentous process which runs to the sternum and which is called the suspensory ligament. Bands of connective tissue extend between the two layers of the membrane; they are called Cooper's ligaments, and they serve as partitions between the glands and tubular structures of the organ. These ligaments are relatively more numerous in the male than in the female breast.

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* Carson, N. B., in Trans. Am. Surg. Assoc., vol. xxii., 1904.

† Klar, in Arch. f. Chir., Bd. xv., March, 1906.

Up to the age of puberty there is no apparent difference between the breasts of the male and female, but when that period is reached the breast of the female develops rapidly, while that of the male changes little, if at all, in its contour or structure. The glands in the male breast are not only smaller and fewer in number, but the tubes are also much fewer in number and straighter in direction than they are in the female breast.

Schuchardt found that only about one per cent of all tumors of the breast were discovered in the male, and that only about two per cent of these were malignant in character. Among the tumors which are found in the male breast the following may be mentioned: adenoma, fibroma, myoma, enchondroma, carcinoma, and tuberculous and syphilitic growths.

It may be said, in general, that tumors pursue the same course in the male breast that they do in the female breast, whether the growth be of malignant or of benign character. Carcinomatous disease of the male breast is a disease of later life, occurring, in the vast majority of cases, after the fortieth year. The history of traumatism as a cause for development of new-growths in the male breast can be more frequently obtained than can a similar history in the case of women.

The treatment of new-growths of the male breast is essentially the same as that employed for the relief of these conditions in the female.

II. WOUNDS OF THE SPINAL COLUMN AND OF THE SPINAL CORD AND ITS MEMBRANES.

Wounds of the spinal column may be produced either by direct or by indirect violence—such, for example, as a blow from a blunt or sharp instrument or weapon, and that which is inflicted by the passage of a bullet. Direct violence may be inflicted on the spinal column through a fall, which causes the body to strike upon some projecting object. Indirect violence to the spine is produced by falls upon the feet, buttocks, or shoulders. Injury may also be produced by forced flexions, torsions, or extensions of the spinal column. Any of these injuries may or may not involve the spinal marrow and its membranes. The injury to the spinal column which follows a direct blow, either from a blunt instrument or from a fall, is sometimes accompanied by a crushing of the vertebral arches or the vertebral bodies. If some penetrating weapon, such as a knife or a bullet, has caused the injury, the underlying bone as well as the spinal cord will probably be injured.

Contusions of the Spine.—Contusions of the spine are usually unaccompanied by injuries of the cord. The spinal column may be sprained as a result of extreme flexion, violent torsion, or hyperextension—distortions which may be produced by falling over a bar or by being thrown forcibly backward in such a manner as to cause the spine to strike against some hard projecting object. Such an injury to the spine occurs most frequently in the most flexible portions, that is, in the cervical and dorso-lumbar regions. The injury, in these cases, is a tearing of muscles and fasciæ which is followed by an effusion of blood into the soft parts, as evidenced by discoloration of the skin and by swelling. In severer cases the ligaments connecting the various segments of the spine are torn and lacerated. This is especially true of the supraspinous and interspinous ligaments, which may be ruptured between the spinous processes of the vertebræ without either fracture or dislocation, and without involvement of the cord. In these cases there may be a rupture of veins and some hemorrhage into the spinal canal,—even into the cord itself. Where hemorrhage takes place there may be symptoms and physical signs—such, for example, as a Brown-Séquard's paralysis, which is a paralysis of one side and an anæsthesia on the opposite side—indicative of spinal-cord injury. The subjective symptoms and the history of the injury are the best guides to a diagnosis where this confusion arises.

Symptoms.—The symptoms of sprain or contusion of the spinal column are: local pain, muscular rigidity, local tenderness, and loss of function. Swelling may exist, but it is usually not observed. If the injury be in the lower part of the spine, or if it involve the cord, it may be difficult for the patient to move the legs, and there may be some disturbance of sphincter function, as well as other symptoms of a cord lesion.

Treatment.—The treatment of contusions of the spine consists in first placing the patient in bed and then making hot applications to the seat of the injury, while at the same time proper support and protection are provided for the spine as a whole. To these measures the condition, as a rule, readily yields. It is important, however, not to prolong recumbency, as contraction of the fasciæ will result and the patient will have a more or less uncomfortable period during the return to activity. The early use of massage should be avoided if it causes severe pain.

Distortions of the Spine.—Another form of simple injury to the spinal column is known as distortion of the spine. This injury is usually produced by a fall on the head, with a bending forward or backward of the body. With regard to injuries of this nature Kocher makes the following comments:—"As long as the continuity of the bodies of the vertebræ and their ligaments is preserved, overextension will simply produce distortion. If extension is associated with torsion, the joint is more affected on the side to which the face is turned. With flexion and rotation, on the other hand, the opposite joint suffers most damage. Sometimes several vertebræ are affected at the same time. The fourth, fifth, and sixth cervical vertebræ are most commonly affected." Ericson's spine, or litigation spine, which properly comes under the head of the functional neuroses, may be associated with an injury received in a railway accident. The patient develops a number of subjective symptoms and may have pain for a number of years after the accident. These symptoms usually subside after "compensation" has been obtained, but sometimes they persist for a long time afterward, and opinion is divided as to the true nature of the nervous condition in these cases.

SYMPTOMS.—The symptoms of distortion of the spine are such as result from pain on movement. The head is held in a stiff attitude, the ear is drawn toward the shoulder of the affected side, and the face is turned toward the healthy side. All motion is avoided, and pressure made upon the head, the lateral joints, the spinous processes, or the neighboring vertebræ, causes pain. Occasionally the symptoms present in these cases point to injury of the cord itself. These symptoms are often due to hæmatomyelia.

DIAGNOSIS.—With regard to the diagnosis of this condition LeBreton* says: "In examining a case, after consideration of the history and the subjective symptoms, the patient is watched to see if there is any change in posture, a stiff gait, and a drawn facial appearance. His method of getting in and out of a chair, of standing with eyes shut, and of raising the knees alternately is observed. The contour of the spine is noted and local tenderness sought. The spinal motions are investigated, and, if limited, whether the limitation is due to pain or spasm. It must not be forgotten that wry-neck and spasm of the cervical muscles may simulate a Pott's disease, the diagnosis being confirmed by the result of treatment. In the neurotic cases a diagnosis must be made largely from the grouping of symptoms and not so certainly by objective signs. It is easy for malingerers to counterfeit the 'railroad' spine." In examining these cases the surgeon should not make a diagnosis on the basis of the objective signs alone.

The treatment consists of fixation and extension of the spine. Recovery usually occurs in from three to four weeks, although the patient should be kept under observation for a much longer period of time. It need not be said that the cord is never crushed as a result of this injury. Where a suit is in progress all the symptoms are liable to continue until a termination is reached. The patient in such cases runs the danger of becoming a neurotic. Such individuals should be advised, for their own good, to settle their litigation.

Stab-Wounds and Gunshot Wounds of the Spine.—In considering such wounds of the spinal column and cord, it is well to bear in mind the fact that vital organs may be injured at the same time, and that the latter damage may induce complications more dangerous to life than the local injury to the spine. Then, besides, it must be remembered that wounds produced by a projectile often cause fracture and that the fracture so caused is of a compound nature; also that the projectile itself, or splinters of bone split off during its passage, may injure the cord. This branch of the subject, however, will be found fully discussed in Major Borden's excellent article on "Gunshot Wounds," in Vol. II.

Stab-wounds, when produced by a sharply pointed knife or weapon, may cause fracture of the spinal arches and severance of the spinal cord. They are far less frequent than gunshot injuries. In gunshot injuries the course taken by the projectile and the region of the spine penetrated are the considerations of greatest importance. Many of those injured in war by receiving bullet wounds in the neck have died from a tearing of the vagus nerve. Under certain conditions an injury to the phrenic nerve may cause instant death. In complicating injuries of the larynx, trachea, pharynx, or œsophagus lies great danger, as, by reason of such a complication, a case of simple injury to the spinal column becomes serious. How dangerous these wounds may be, may be learned from the reports of the injuries to the larynx which were observed during the American Civil War. Of those who were injured in the region of the larynx, fifty per cent died from their wounds; and in the Franco-German war the mortality of this group of wounds was 55.7 per cent. With regard to the injuries produced in the vertebral column itself either by projectiles or by penetrating weapons, these may be divided into three groups of cases: those in which the spinal canal is not opened; those in which the spinal canal is opened but the spinal marrow escapes injury; and, last, those in which the spinal canal has been penetrated and at the same time the spinal marrow and a spinal nerve root have been destroyed. In the first of these groups the symptoms would be those of concussion, which would spontaneously disappear; and the greatest danger would be from injury to an artery, which might result in fatal hemorrhage. As a general thing, however, this class of injuries produces only disturbance, of a mechanical nature, in the head or neck movements, or in the sensibility or motive power of these parts. Injuries of the second group, where the shot penetrates the spinal canal without penetrating the spinal marrow, are usually accompanied by hæmatoma or by the lodgment of a piece or of pieces of bone in the immediate neighborhood of the cord; in either of which cases pressure on the intact dura—and through it upon the spinal marrow—may be looked for. If the pressure be due to the presence of an hæmatoma, loss of power will, in most cases, develop slowly and disappear spontaneously; but, where it is due to fragments of bone or to the projectile itself, loss of power comes suddenly and is permanent; only laminectomy and removal of such pressure will give the patient a chance for recovery. In the cases belonging to the third group the prognosis is bad, as the spinal marrow itself is injured more or less completely by the passage of the bullet or by the point of the weapon. Death may follow immediately, or, less fortunately for the patient, it may occur after a more or less prolonged and painful illness, made exceedingly uncomfortable by the presence of bed sores, cystitis, and more or less complete helplessness.

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* Le Breton: "Spinal Sprain," in Jour. Amer. Med. Assoc., May 23d, 1908.

In injuries of this nature the question arises as to the advisability of operation. Operative interference is indicated when there is evidence that splinters of bone have been dislocated and that the cord is compressed by their presence or by the presence of the projectile itself. The *x*-ray is of the highest value in establishing these facts. It is to be borne in mind that apparently slight lesions will cure themselves, and that serious lesions are seldom relieved by operative treatment. Prewitt,* basing his experience on the cases seen in the Spanish-American War, is in favor of operating when accessible parts have been struck and the condition of the patient justifies operation. Of fifty-eight cases of wounds of the spine seen by him, thirty-three ended fatally; and, of the twenty-five which were operated upon, twelve recovered. Schmidt,* at a meeting of surgeons in Berlin, March, 1902, also expressed himself in favor of operation. From the German government statistics, he showed that, of those operated upon for injuries of the spine 62.5 per cent lived, while of those who were not operated upon, only twenty-four per cent recovered. The following reports of cases, more or less condensed, will give a fair idea of the conditions met with:—

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* Prewitt: "Gunshot Wounds of the Spine," in Annals of Surg., 1898.

Case 1.†—The patient, a boy of 13, was shot in the back, July 27th, 1904, with a pistol (5 mm. calibre). The ball penetrated between the fifth and sixth dorsal vertebræ, to the right of the median line. Complete paralysis of the lower part of the body resulted, and among the other symptoms observed were: entire absence of tendon reflexes; lack of sensibility; Babinski phenomena; and paralysis of the bladder and rectum.

The patellar reflex returned, on the right side, on the tenth day and, on the left side, on the sixteenth day after the injury. The tendon reflexes and the power of motion (right side) also gradually returned. On the left side tactile sensibility slowly increased. A little over five weeks from the day of the injury, the boy's symptoms were like those of a Brown-Séquard one-sided lesion of the cord; the inference being that the left side of the spinal marrow was more severely injured than the right. By aid of radiograms it was ascertained that the ball was located in the vertebral canal at the height of the sixth dorsal vertebra.

Operation on the 3d of June (thirty-seventh day after the injury) by W. Braun. Some pieces of cloth were first removed from the dura which had become closely adherent to the ligamentum flavum. Then, as the ball was not discoverable outside the dura, an opening was established in this membrane and the cord itself was exposed to view. It showed plainly evidences of having been damaged. The ball was found to have lodged in the region of the left anterior ligament and to have encroached somewhat upon the anterior cornu of the cord.

Patient stood the operation well. Four hours afterward, no change in the reactions of the affected nerves could be demonstrated. Six days later, the Babinski symptoms were found to have disappeared, and the boy was able to lift his left leg. Healing of the wound took place promptly and with scarcely any fever.

Case 2.‡—A man, 30 years old, came to the hospital on July 10th, 1904, saying that he had been shot in the small of the back, and complaining of extreme pain. It was noted that the bullet had entered the body at a point corresponding to the top of the third lumbar vertebra, below the ridge of the right ilium, and at a distance of about three finger-breadths from the median line. The parts in the immediate vicinity of the wound were extremely sensitive to pressure. The wound itself bled profusely. The patient was unable to retain his urine. As the severity of the pain was on the increase, morphine was administered. Soon afterward the patient complained of a dull pain in his head.

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* Schmidt, Hermann: "Schussverletzungen der Wirbelsaeule," in Deut. Milit. Zeit., 1904.

† Wilde: "Schussverletzung des Rueckenmarkes," in Deutsche med. Wochenschr., Leipzig u. Berlin, 1904, xxx., 1451.

‡ Engelmann (F.): Akute Compression der Cauda Equina durch ein Projektil; Operation; Heilung. Muenchen. med. Wochenschr., 1904, li., 2292-2294.

In the afternoon of the following day the patient was carried, in a collapsed condition, to the *x*-ray room, and it was then ascertained that the ball was located exactly in the median line, within the limits of the space occupied by the first or second lumbar vertebra, below, and the last dorsal vertebra, above.

July 12th.—Ischuria in the place of incontinence.

July 13th and 14th.—Patient complains of severe pains which seem to shoot from the back toward the legs. He expresses the wish that an attempt be made to extract the bullet.

July 15th.—Operation. An incision, 12 cm. long, was made from the last dorsal vertebra, above, in a downward direction as far as to a point close to the third lumbar vertebra. This incision laid bare the bullet, which had lodged between the last dorsal and the first lumbar vertebra. The extraction of the leaden ball and of a second smaller piece of lead was readily accomplished after the wound had been suitably enlarged. The loss of blood during the operation was slight.

On the day following the operation, the pains, of which the patient had previously complained, were not so severe. As an offset to this gain, however, the patient began to be troubled a great deal with constipation, and a very painful swelling developed in his left testicle, giving rise to evening elevations of temperature.

On July 25th, he had a spontaneous movement of the bowels for the first time. The wound had entirely healed; the patient got up for the first time.

July 31st.—Temperature normal during last four days. Patient urinates spontaneously. Entire cessation of the severe pain; patient occasionally complains of pulling pains which radiate toward the legs.

August 8th.—Patient complains of lack of control over his bladder, which is the seat of a rather severe cystitis. Otherwise his bodily condition is good.

CASE 3.*—"Mrs. ——, 20 years of age, was shot July 11th, 1904, at close range with a 32-calibre revolver. Bullet entered left side of the body at the level of the eighth rib. Immediately taken to Rhode Island hospital in a state of collapse. Physical examination showed a well-developed and fairly well-nourished woman. Skin and mucous membranes very pale. Pupils equal and slightly dilated. Heart and lungs negative. Wound of entrance made by the bullet was found on the left side of the trunk in the anterior axillary line surrounded by an area of burnt and discolored skin. Abdomen tender; no dulness in the flanks, but marked rigidity of the abdominal muscles. Complete motor paralysis of both lower extremities, though the patient could move both thighs a trifle; both lower extremities hyperæsthetic. Pulse rapid, of poor volume and tension."

[The operation, which was performed shortly after the occurrence of the shooting, had reference only to the intra-abdominal conditions, and a description of it may, therefore, be omitted in this place. It proved successful, so far as these particular conditions were concerned, and opened the way for the performance of a later operation, the object of which would be the removal of the pistol ball that was evidently pressing upon the spinal cord.]

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* Pegram (J. C.), jr.: "Penetrating bullet wound of abdomen passing through the spleen stomach, vertebra, and spinal cord; laparotomy and suture of stomach wounds; recovery; subsequent laminectomy and removal of bullet from spinal cord; recovery." Med. Age, Detroit, 1906, xxiv., 801–805.

July 21st.—*X*-ray picture shows bullet in a line with the first lumbar vertebra and pointing upward. Leucocyte count, 17,680. Ability to move legs increasing, but patient did not move the left as well as the right.

July 27th.—Pain in legs extreme. Leucocyte count, 16,200. A second *x*-ray picture, taken with the source of light placed on one side at a definite angle, showed a bullet apparently lying in the spinal canal.

July 30th.—Laminectomy performed. Patient placed face downward on the table. Incision five inches long was made in the median line between the eleventh dorsal and the fourth lumbar vertebræ. Muscles and fascia dissected away from the spinous processes and laminæ of the vertebræ on both sides. Bleeding was controlled chiefly by packing each side of the spinous processes with gauze for a couple of minutes. With the idea in mind of trying to save the long spinous ligament, in order not to weaken the back too much, the following operation was planned and carried out:—First, the spinous processes of the twelfth dorsal and first and second lumbar vertebræ were split longitudinally with a thin-bladed saw down to the laminæ. The supraspinous and interspinous ligaments were then split longitudinally with a knife, this division making a straight line with the division of the spinous processes. Next, the spinous processes were severed from the laminæ with a heavy wire-cutter shaped like a blacksmith's tongs. In order now to get at the laminæ and still preserve the ligament so that it could be replaced, I severed each half of the split ligament at opposite ends. These two halves of the ligaments, including the halves of three spinous processes, were then turned out on either side, and the spinal canal was opened in the usual manner. The bullet lay under the laminæ of the twelfth dorsal vertebra in the right posterior cornu of the spinal cord, which latter must have been traversed by the projectile and was considerably lacerated. A drain of plain gauze was led down to the rent in the meninges which yet made no attempt to close. The two halves of the supraspinous ligament were re-approximated and sutured with black silk, restoring its continuity. The muscle and skin incisions were closed with black silk sutures, leaving a small opening for the drain.

"Patient stood the operation as well as could be expected. She was put to bed on a Bradford frame, face downward. Good recovery from ether.

"July 31st.—Voluntary control of the tibiales antici was noted to be present, but weak. Patient moved right quadriceps adductors; same true on left side, except that the impulse was weaker and the quadriceps extensor did not respond."

During the month of August the following events occurred:—

On Aug. 4th the sutures were removed from the back and the patient was turned over on her back. By the 18th (*i.e.*, thirty-eight days after the shooting) the abdominal wound had entirely healed, but there still persisted a small sinus at the site of the incision in the back. On Aug. 22d (the twenty-third day after laminectomy) a plaster jacket was applied; on the 30th the patient went home; the pain in one leg being the symptom of which she complained chiefly.

An examination made by Dr. George L. Shattuck, on Feb. 8th, 1905, revealed the fact that there was an extensive area of anæsthesia (of both tactile and temperature senses) involving the cutaneous surfaces of both lower extremities. His inference is that the injury done to the cord by the bullet must have set up a transverse myelitis.

Dr. Pegram believes that if the patient continues to regain her lost functions at the present rate of progress, a disappearance of almost all the motor and sensory disturbances may be looked for.

In cases of complete division of the cord, either by a bullet or by a stab wound, the question of suturing the cord arises. Up to the present time there is no evidence to show that the nervous elements of the cord in mammals will undergo regeneration. Restoration of function, however, does occur in some of the lower orders of life, as in some of the amphibians, in the reptiles, and in some birds; and, while it has been proved by experiment that partial restoration of function does take place in very young puppies after total section of the cord, it is a fact that true nerve filaments have never been found in the cicatrices in older animals. There have been reported lately several cases of suturing of the cord after complete severance, notably that reported by Stewart and Harte and that reported by Fowler, in both of which instances the individuals upon whom the operation was performed were at last accounts still alive, after the lapse of several years, and had recovered some of their functions—some of them completely and others partially. As an explanation of this result it is assumed that some of the nerve filaments probably escaped injury, or else that, by adhesions of nerve filaments, above and below the destroyed part, to the dura, these filaments ultimately became reunited and were thus able in some measure to perform their normal function. Despite the fact that experiments have failed to show a regeneration of nerve elements, we have the well-authenticated cases mentioned above to prove that, by some means or other, function may be at least partially restored and the lives of the patients prolonged and made comfortable. Laminectomy, therefore, as well as suturing of the cord when practicable, would seem to be sufficiently justified, if only for the purpose of giving the patient a chance to secure that degree of repair which appears to have been granted to others.

Symptoms and Diagnosis.—The symptoms of stab-wounds or gunshot wounds of the spinal column or cord correspond in a general way to the symptoms of fracture, fracture dislocation, compression, and contusion of the cord. The diagnosis of the exact region affected is often aided by the use of the *x*-ray, although at times splinters of bone in the vertebral canal cannot be shown in the radiograms. The question of diagnosis is usually settled by the nervous phenomena present. As a rule, the localizing sensory changes appear early.

Treatment.—The treatment, as laid down by the modern military surgeons, is to leave the wound alone, only protecting it from infection from the outside. This applies to gunshot wounds as well as to stab-wounds. After the sensory localizing symptoms have appeared, and when a radiogram shows that the bullet or a splinter of bone is causing compression of the cord, then operation for the relief of such pressure is indicated. Where there is evidence showing that nerve roots have been torn, it is well to suture these. The question of waiting until the wound caused by the projectile or weapon has healed, is one that must be settled in each individual case. If fitting treatment can be employed, it is perhaps better to wait, as thus the danger of infection is made less. However, it must be remembered that pressure upon the spinal cord or its membranes, when continued for long, is apt to result in local destruction of the cord.

FRACTURE-DISLOCATIONS, SIMPLE FRACTURES, AND SIMPLE DISLOCATIONS OF THE SPINAL COLUMN.

According to Keen* sixty per cent of the fractures of the spine are fracture dislocations, while twenty per cent are simple fractures, and the remaining twenty per cent are simple dislocations.

Henle, in his article on the surgery of the spinal cord and vertebral column,† says: "It is a great service of Kocher's to have arranged compendiously, according to clinical points of view, the injuries of the vertebral column, the number of which, in consequence of the various constituents of the whole column and of every single vertebra, is very large. The principle of classification adopted by Kocher should therefore be here maintained. In consequence of this the principal groups will not be formed, on one side, by fractures, and on the other by luxations, because clinically these often do not differ from one another and very often are combined together. Kocher, moreover, places the *partial injuries* over against the *total injuries.*

"With a few digressions from Kocher's subdivision, required by practical considerations, we shall differentiate injuries of the spine into the following subdivisions:

"I. PARTIAL INJURIES OF THE VERTEBRÆ. (1) Distortions; (2) Isolated Luxations of the Lateral Articulations; (3) Contusions; (4) Isolated Fractures of the Bodies of the Vertebræ (especially compression fractures); (5) Isolated Fractures of the Arches and Processes.

"II. TOTAL INJURIES OF THE VERTEBRÆ. (1) Total Luxations (Luxation of the Lateral Articulations and Dislocation in the sphere of the intervertebral cartilage). (2) Luxation-Compression Fractures (Luxation of one or both of the lateral articulations and compression-fracture of the body). (3) Total Luxation-Fractures, Luxation-Oblique-Fractures (Luxation of the lateral articulations and dislocation in the region of the fractured vertebra)."

It does not seem practicable, with the opportunities which I have at my command, to arrange spinal injuries strictly in accordance with this classification, excellent as it is in the abstract. I shall therefore, largely as a matter of convenience, discuss the subject of spinal injuries under somewhat different heads.

Isolated Fractures of the Spinous and Transverse Processes and the Laminæ.—Isolated fractures of the spinous and transverse processes and the laminæ occur chiefly in the cervical region. Fractures of the spinous processes have occurred (in combination with other lesions) in about eight per cent of the cases, and.

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* Keen, in Dennis' "Surgery," vol. ii., p. 811.

† Page 812 of vol. ii. of von Bergmann and Bruns' "Handbuch der praktischen Chirurgie," dritte umgearbeitete Auflage, Stuttgart, 1907.

as an isolated condition, in about four per cent of the cases. These fractures practically never cause danger to life. Fractures of the laminæ may occur as isolated conditions, and, when they do, it is usually in the cervical region. They are generally accompanied by pain, more or less severe, and localized tenderness, the presence of the fracture being made out by palpation.

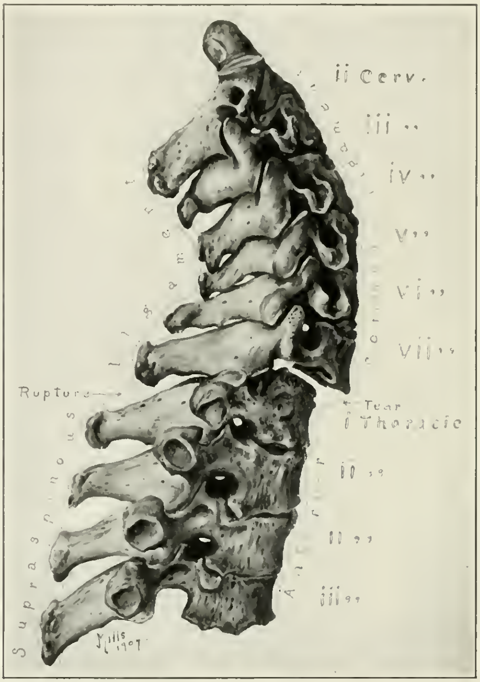

FIG. 307.—Dislocation of Vertebral Articulation in Cervical Region, with Rupture of the Anterior Longitudinal and Spinous Ligaments. (Fry's case.)

Fractures of the Atlas and Axis. The intimate relationship of the atlas and axis with the medulla oblongata makes an injury in this locality especially dangerous. Gurlt* has shown that, in eleven cases in which fracture of either of these vertebræ was demonstrated, by autopsy, death occurred immediately in but two, and in only two others within an hour after the injury was received. In the other cases the patient survived for varying lengths of time up to (in one instance) thirteen days, although some of them died at last suddenly, probably in consequence of displacement of the fractured vertebræ. These fractures are always the result of external violence. It is to be remarked, however, that the violence is sometimes slight, such as a fall out of bed or from a hammock. In Gurlt's cases the odontoid process was broken in but one instance; the odontoid process and posterior arch of the atlas, three times; the posterior arches of the atlas and axis, three times; the posterior arch of the axis alone, once; the spinous process of the axis, twice. The articular processes of the cervical vertebræ are set well out from the body—to such an extent, in fact, that any force, which would tend to push a vertebra forward, providing it were great enough to overcome the ligamentous protection common to all vertebræ, would not find the bony obstruction which, lower down, the anterior aspect of the inferior intervertebral notch offers to the posterior aspect of the superior intervertebral notch of the vertebra immediately below it. In fact, the articular surfaces are so loosely apposed, in the cervical region, that very little additional longitudinal separation is required to render possible a complete luxation forward or backward, according to the direction of the force applied.

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* Gurlt: "Handbuch der Lehre von den Knochenbruechen," Hamm, 1862.

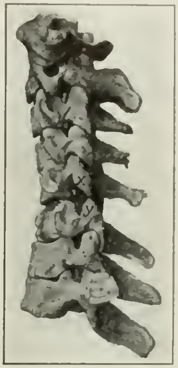

Fig. 308.—One-sided Dislocation of a Cervical Vertebra. (From de Quervain's "Spezielle chirurgische Diagnostik," Leipzig, 1907.)

The lower edge of the articular process of the dislocated vertebra (*x*) rests upon the upper edge of the articular process (*y*) next below it. In a case like this, in which there has been no crushing of the bone, the usually accepted rule that the head is turned toward the side of the dislocation—would not hold good. Theoretically, at least, we should have to assume here a different manner of holding the head.

Symptoms.—The symptoms of fracture or dislocation of these upper two vertebræ are quite indefinite and variable, it being all but impossible to differentiate a simple dislocation from a simple fracture or from a fracture-dislocation. There is usually complete paralysis of all parts below the lesion. In some cases, however, the paralysis may be only partial or may be simply a diminution of sensibility in one extremity. In addition, there are usually pain and rigidity; or death may occur suddenly. In the cases in which the patient survives the injury, the diagnosis may be made clear by the use of the *x*-ray.

Bilateral Isolated Dislocations.—Bilateral isolated dislocations may occur without injury to the cord. They usually follow a blow upon the nape of the neck or a fall backward on the head. Their existence, in any given case, is revealed by the *x*-ray and by the position of the patient's head, which may be retracted, with the occiput drawn down between the shoulders, while the chin is thrown forward. The muscles on each side of the neck in most cases are more or less prominent. The head is generally fixed and rigid, but in one case seen by the author it was freely movable, and when traction or extreme movements were made the patient complained of a "warm tingling sensation," which radiated through the neck and shoulders and down the ulnar sides of the arms.

Deformity may be present in a marked degree, but in the case referred to above, although the luxation was complete, it was impossible to discover the slightest displacement of the spinous processes. If the dislocation is in the upper cervical vertebræ the body of the displaced vertebra may be felt in the pharynx.

Hemorrhage into the cord is the only dangerous lesion which is likely to be associated with the dislocation.

Treatment consists in attempts at immediate reduction, always under anaesthesia. Direct traction should be employed first, great care being exercised to prevent over-extension or undue flexion, as the already lacerated or compressed cord may be completely separated or still further compressed by the manipulation. On account of complete rupture of the ligaments, which is sometimes present, the direct traction method, in Hueter's belief, is too dangerous, and he therefore advises reduction by rotating movements. By this method the head is rotated strongly toward one shoulder, thus causing the opposite articular process to be set free from its interlocking with the one below, and restored to its normal relations to the latter. The same manœuvre is now repeated on the other side and the corresponding articular process is dislodged and finally reduced. (Fowler.)

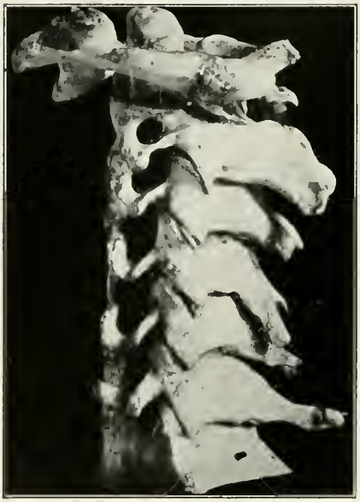

FIG. 309.—Dislocation of Both Articular Processes of Atlas on Axis, Suicide by Hanging. (Specimen from the Muetter Museum, Philadelphia.) (Allen: "Injuries to the Spinal Cord." *Jour. A. M. A.*, March 21st, 1908.)

If these measures fail, we should explain fully to the patient and to his or her friends the necessity for operative interference; and at the same time we should warn them that success may not attend the procedure. After the parts involved have been thoroughly exposed by dissection, reduction should again be attempted with the parts fully in view, after the method advocated by Hueter. If failure again results, laminectomy should be resorted to.

Unilateral Dislocations.—The tables of Ashhurst,* which are based upon three-hundred and ninety-four cases of spinal injuries, show twenty-nine instances of unilateral dislocation. It is impossible, however, to determine, with any degree of precision, the relative frequency of unilateral dislocations. Owing to the fact that, in the cervical region of the spine, the bodies of the vertebræ are small and the interlocking of the articular processes is less firm than it is lower down in the spinal column, most of these dislocations take place in that region. (Figs. 307–313.) The fifth cervical vertebra, as might be expected, is most commonly dislocated, on account of the fact that neck flexion and extension are freest between the third and sixth vertebræ. The horizontal position of the articular processes in the cervical region is another factor which renders dislocation easiest here. Possibly some of these dislocations go unrecognized by reason of the practitioner's lack of familiarity with the characteristic features.

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* Ashhurst: "Injuries to the Spine," 1876.

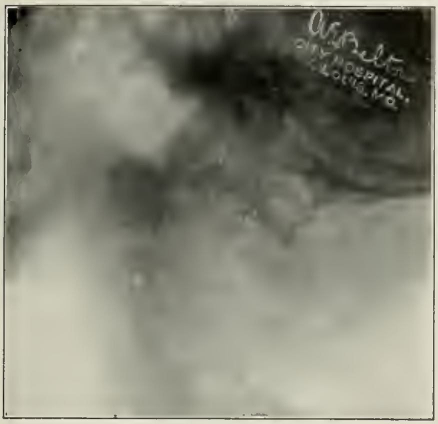

Fig. 310.—Skiagram Showing Dislocation Between Second and Third Vertebræ in the Cervical Region of the Spine. (City Hospital, St. Louis.)

These unilateral dislocations take place in the following manner: The articular process of the upper vertebra on the dislocated side slips forward; in the incomplete form it rests on the crest of the lower articular facet, in the complete form it drops into the intervertebral notch and rests on the pedicle of the vertebra below; the articulation on the opposite side holds; the intervertebral disc may or may not be torn; the spinal canal is very slightly encroached upon. As to the causes of these dislocations, Volker* has collected fourteen cases in which the displacement was due to muscular action alone, and two of Walton's cases give similar histories. Schiele† reports a case of a man who went to sleep with his head hanging over the bedrail, and, on waking, suddenly lifted his head and incompletely dislocated one of his upper vertebræ. Any sudden, violent, or ill-regulated turning, with perhaps an inclination to one side, may produce a dislocation of the vertebræ. It may also be produced by external force such as a fall or a blow on the side of the head or neck.

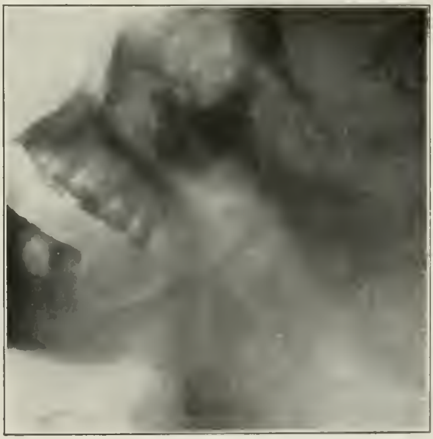

Fig. 311.—Radiogram of the Same Case (Fig. 310), Showing the Altered Position of the Parts After Attempted Reduction. (City Hospital, St. Louis.)

The points which should be borne in mind in connection with a unilateral dislocation of the cervical vertebræ are these: the proximity of the phrenic nerve, and the danger that death may occur from respiratory inhibition; and to these may be added the slight danger that the vertebral artery may be subjected to such violence that a rupture of its walls will occur.

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* Volker, in Deut. Zeitsch. f. Chir., 1876, vol. vi.

† Schiele, in Deut. med. Wochens., 1904, vol. xxx., p. 100.

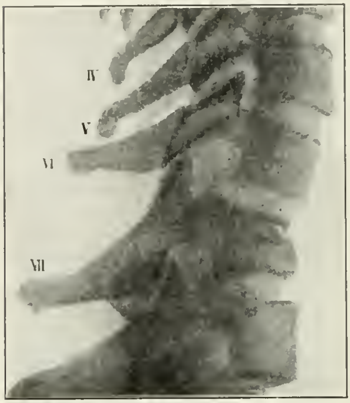

Fig. 312.—Fracture-Dislocation of the Seventh Cervical Vertebra. (From de Quervain's "Spezielle chirurgische Diagnostik," Leipzig, 1907.)

Diagnosis.—The diagnosis is established by the presence of the following symptoms: rigidity of the neck, and the fact that the patient holds the head with the face turned toward the side opposite to that of the dislocation. Such a dislocation is differentiated from torticollis by the following facts: in wry-neck the muscular fibres of the sterno-mastoid are contracted and tense on the side opposite to that toward which the face is turned, while in unilateral dislocation this muscle is taut on the side toward which the face is turned. The history of injury is also important as an aid to diagnosis. Walton* says: "The side on which the dislocation has occurred can therefore always be determined by the direction of rotation; the question whether the articular process has slipped into the notch may be determined by the tilting of the head." He observed twelve cases, and in only two of these did paralysis occur—probably through root pressure.

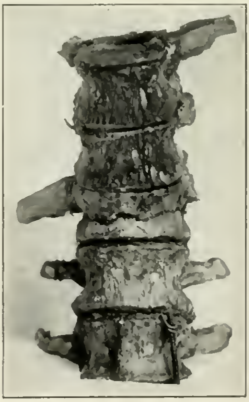

Fig. 313.—Compression Fracture of Vertebral Body. (Washington University Museum, St. Louis.)

Prognosis.—The prognosis is more favorable in the unilateral than in the bilateral cases. Ashhurst's cases, numbering twenty-nine, showed nine deaths. Malgaigne† reports twenty-six cases, in seventeen of which the patients recovered. Dislocation above the origin of the phrenic nerve are the most fatal because of the contiguousness of the medulla.

The treatment of this condition has lately undergone a change and operators are following the directions of Walton in performing what he styles "retro-lateral flexion with rotation." The patient is anæsthetized while sitting in a chair. The operator stands behind, and, grasping the head with both hands, turns the face still farther away from the dislocated side. The head and neck are then tilted to the sound side. This makes the dislocated facet rise above the facet below. The last motions are extension and rotation of the column backward into place, and the reduction is then complete. This method has a great advantage over extension, for attempts at reduction by extension alone make it necessary that the vertebræ should be widely separated at every point in order that the dislocated articular process be sufficiently elevated to slip back into place.

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* Walton, in Boston Med. and Surg. Journal, 1903, 445.

† Malgaigne: "Treatise on Dislocations," 1848.

The author believes that the following case history, recently published by Dr. Clopton,* of St. Louis, is of sufficient interest to justify him in reproducing it here *in extenso*.

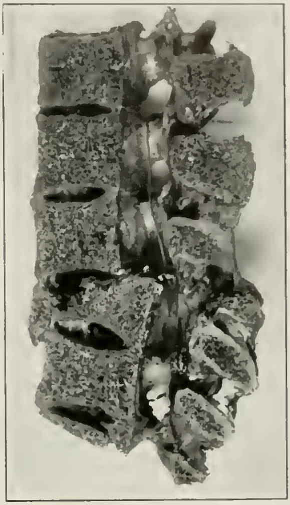

Fig. 314.—Compression Fracture of Vertebral Body. (Washington University Museum, St. Louis.)

"C. H., a healthy muscular youth of 19, during an athletic exhibition, was walking on his hands. His right arm weakened under him and he fell, striking his head on the left side and coming down on his left shoulder. He heard a distinct snap just after his head struck, felt a sudden pain in his neck, and realized that he was unable to bend his neck. He walked away and later visited a dispensary where, the injury being unrecognized, liniment was ordered for the soreness; and later, on the same day, he visited another clinic, where, on account of the serious nature of the injury, he was referred to the Mullanphy Hospital, where I saw him twenty-four hours after the accident. He was up and about, as any reclining posture gave him great pain, and he had been unable to sleep the night before. His neck and head were held rigidly, the face turned to the right and downward. The neck was directed slightly to the left, and low down, at the base of the neck, on the left side, was a rounded enlargement which was very tender. The sternomastoid on the left side was relaxed, but on the right side it was tense. Movement was limited to a slight forward and backward nod of the head, and any attempt to straighten the head was very painful. On account of the much-developed musculature it was impossible to feel with any certainty the spinous processes, or to determine what was the nature of the enlargement on the lower left neck, or to make out the transverse processes. There was no nerve disturbance of the arms or of any part of the body. The patient walked perfectly well, but complained of some pain in the neck with the jolting of each step. To confirm the diagnosis of left unilateral dislocation of the sixth cervical vertebra, an *x*-ray photograph was made. Under ether, which was administered to the patient while in a sitting position, a reduction was easily accomplished by Walton's method of retro-lateral flexion with rotation."

Isolated Fractures of the Vertebræ.—Isolated fractures of the bodies of the vertebræ are caused by a fall upon the head, neck, sacrum, or feet. They are rare in the cervical region and most common in the upper lumbar and lower dorsal regions. (Figs. 312, 313, and 314.) In these cases a certain amount of antero-posterior deformity is noticeable, although this may be so slight as to be overlooked; it disappears when the patient is in a recumbent position, but returns when the erect posture is resumed. Where a skiagram has revealed an isolated fracture of the arches or spines, or an isolated fracture of the body of a vertebra, and where in addition the involvement of the cord is shown by an increasing paralysis, the advisability of immediate operative intervention, for the purpose of relieving pressure upon the cord and its membranes, should receive serious consideration. The following case, reported by the late Dr. McCosh,* well illustrates this point.

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* Clopton, in Interstate Med. Jour., July, 1908, vol. xv., No. 7.

"J. L., male, age 27, was thrown from a railway train, July 3d, 1891, striking on his back. For a few minutes consciousness was lost. When he was brought to the hospital, three hours later, there were found to be complete muscular paralysis of both lower extremities, retention of urine, and loss of power over the rectum. He was in a condition of slight shock; temperature 100° F., pulse 110. There was complete loss of sensation below a line that crossed the body just beneath the tip of the ensiform cartilage. Tendon reflexes in both knees, as also the cremasteric and abdominal reflexes, were completely lost. At the end of eight hours after the accident his temperature had risen to 103.5° F.; loss of motion and sensation, and patella reflexes remained as before. On examination of his back there was found to be a depression below the seventh dorsal spine, at which point there was marked tenderness. The diagnosis of fracture of the seventh dorsal vertebra was made and operation advised. One hour later, that is to say nine hours after the injury, ether was administered. An incision was made from the fifth to the eighth dorsal spines. The spinous processes and laminæ of the seventh dorsal vertebra were found shattered into several fragments. A line of fracture extended forward on the right side into the transverse process. Four or five bony fragments were removed. The dura was lacerated and the cord was contused, markedly congested, and studded here and there with small hemorrhages. A probe passed upward and downward met with no further obstruction. The wound was left partially open, as was also the dura. The shock of the operation was slight, the patient making an excellent recovery.

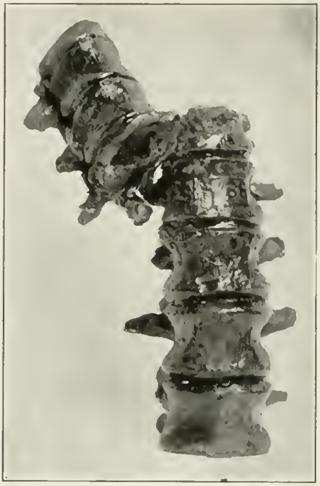

FIG. 315. Fracture-Dislocation of the Spine. (Washington University Museum, St. Louis. This specimen is interesting in that the individual lived long enough for bony union to take place at the seat of the dislocation.

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* McCosh, in Jour. Amer. Med. Assoc., August 31st, 1901.

For five days no special change in symptoms was noted. He then began to feel some tingling and pricking on the outer side of his thighs and legs. On the fourteenth day he was able to move his toes a little, and at this time sensation began to return to his lower extremities. Improvement continued; he began to gain control of his bladder and rectum. On the thirtieth day he could draw his legs up and down in bed, flexing his knees. His patella reflexes had returned to a slight degree in each knee. On the sixtieth day he was able to sit up in a chair, and sensation was rapidly returning. He left the hospital on the seventy-sixth day after his accident, and at that time he could walk when supported on each side. He came to see me three months later and reported that he was about to resume his work. He still felt some slight weakness in his lower extremities, but sensation and his patella reflexes seemed normal. Some five years later he met me on the street and reported that he was perfectly well and that his back was as strong and as limber as ever."

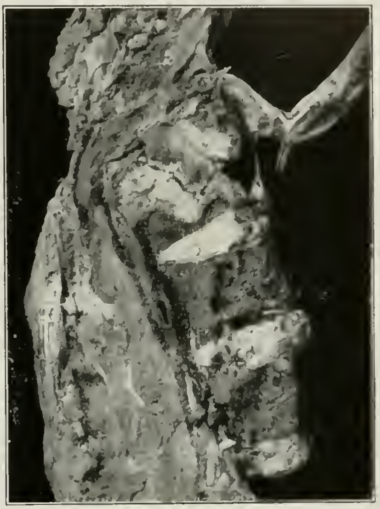

Fig. 316.—Fracture-Dislocation of Ninth and Tenth Thoracic Vertebræ. (From Allen: "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

The author has encountered in practice a case somewhat similar to the one just narrated. In this case the pressure upon the cord was relieved by reduction of the dislocation. The deformity produced in the spine was marked, and for over two and one-half hours there was complete loss of function below the level of the injury, which was in the dorsal spine. The patient was suspended and the dislocation reduced. There was complete restoration of function in less than three months; and at the present time—nearly twenty years after the accident—the patient is perfectly strong and very active.

Complete Fracture-Dislocations.—In many of these cases the injury of the cord is a complete one. Among the cases reported by Wagner and Stolper, Kocher, and others, there were many in which the cord showed complete rupture; and in all there was a complete transverse lesion of the cord, making the duration of life depend chiefly upon the height of the injury. Deformity of the spine may be an important guide to the location of the point of injury, but one should guard against the danger of being misled by multiple injuries and an unusual direction of the line of fracture. Sensory and paralytic symptoms are of the greatest value for the diagnosis of the location of the injury to the cord, but it must be borne in mind that this is apt to be higher than the symptoms would indicate. It is usually possible to correct the narrowing of the spinal canal in these cases of fracture-dislocation by hyperextension and extension of the spine. The extent of the injury to the cord from hemorrhage may be very great. The nature of the injury in these cases depends more upon the character of the accident than upon anything else. Hence the importance of obtaining as good an account as possible of the way in which the injury occurred.

A positive physical sign of fracture may sometimes be obtained by auscultation of the spine. Such a sign, according to Ludloff,* is crepitation over the spine, which is audible with the stethoscope in a certain number of instances. He quotes a case in which, after fracture of the clavicle, the patient's other pains were ascribed to hysteria or simulation. For eight years she was unable to obtain relief, until finally auscultation revealed a creaking over the seventh cervical vertebra. A radiogram showed plainly that this vertebra was fractured, the lesion having evidently occurred at the time when the clavicle was broken.

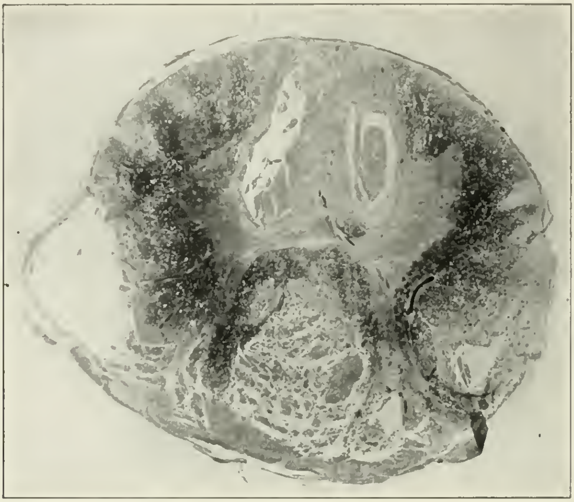

FIG. 317.—A Section of the Spinal Cord Immediately Above the Seat of Compression, showing well-marked degeneration and disintegration of cord substance. (From Allen: "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

These cases of fracture-dislocation may be divided into two classes: (1) those in which there is no injury to the cord; and (2) those in which there is more or less marked interference with the functions of the cord, by reason of the traumatism (laceration or compression) which it has received. (Figs. 315–318.)

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* Ludloff, in Muench. med. W., No. 25, 1906.

PATHOLOGICAL CHANGES IN FRACTURES OF THE SPINE IN GENERAL.

As regards the regions chiefly affected by fracture-dislocations, it may be stated that, in about one-half of the cases, it is the cervical and the lumbar regions which are involved, while in the remaining one-half the dorsal region is the one in which the fracture occurs. Allen* says: "A vertebral dislocation presupposes, in the first place, a greater or less disturbance of the integrity of the intervertebral discs between the bodies of the two vertebræ in question. One finds numerous cases cited in literature where, on post-mortem examination, the intervertebral disc has been pronounced uninjured. I consider this an absolute impossibility. A more careful histologic study would have determined a torn disc." Most of the dorsal fracture-dislocations involve the eleventh or twelfth dorsal vertebra. These produce the lumbar type of paralysis and consequently may be classed with the lumbar fractures. According to Bailey,† the injuries to the bones are of great surgical interest, but the whole importance of this subject centres about the injury which is produced in the cord, and all clinical expressions should be in terms of segments of the cord rather than of bone.

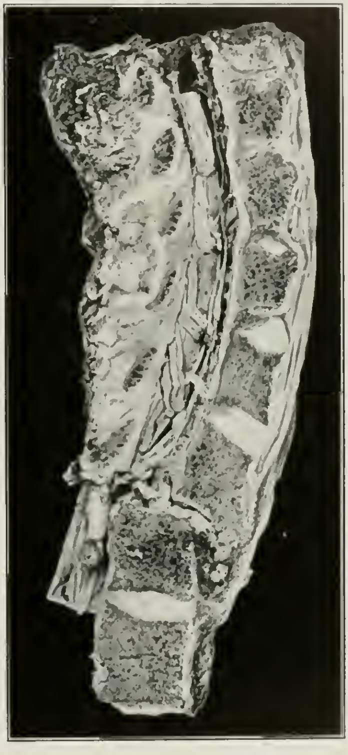

FIG. 318.—Fracture-Dislocation in the Dorsal Region, with crushing of intervertebral disc and complete destruction of the cord. (Allen, "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

As far as the membranes of the cord are concerned, they are practically never injured alone. They may be lacerated, and the lacerations may cause extensive bleeding within the spinal canal, either inside or outside the dura. It is Bailey's opinion, however, that this never occurs as an isolated lesion; that is, it never occurs without there being an extensive contusion of the cord associated with the bleeding. This condition, known under the term of hæmatorrhachis, has played quite an important rôle in the clinical history of spinal-cord injuries. A special symptomatology has been constructed for it, the chief stress being laid upon shooting pains. The surgeon is on the alert for this symptom, with the idea of relieving pressure and, as a consequence, relieving the symptoms. Bailey believes that there is very little use in operating for this condition as he has never yet seen a case of pure hæmatorrhachis.

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* Allen, in Jour. Amer. Med. Assoc., March 14th, 1908.

† Bailey, in Med. Rec., March 3d, 1907

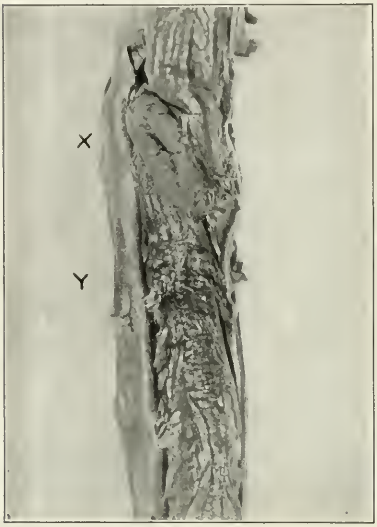

FIG. 319.—Spinal Cord Showing Destruction Due to Crushing at the Seat of the Injury. (Allen: "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

The injury to the cord may be a contusion, a laceration, or a complete severance. Externally, it may show the effect of the injury by dents, punctate hemorrhages, or displacements. On the other hand, it may be severely injured in its structure and yet show nothing abnormal on its exterior, the damage being apparent only when the cord is sectioned. In the cases which have not proved immediately fatal, and which have come later to operation or autopsy, the cord has been observed to be bound down by adhesions to the dura, and the dura by adhesions to the bony canal, the cord being shrivelled to one-third its normal size. On removal and section, the cord shows to the naked eye a derangement of its constituent parts, with displacement of the gray matter, fissures, discolorations, and hemorrhages. Microscopic examination shows a picture which is usually described as traumatic degeneration—that is, the spinal-cord elements show evidences of disintegration—viz., large round cells, myelin drops, blood cells and blood pigment, nerve cells and nerve fibres in various stages of degeneration. In old cases the whole picture is obscured by an overgrowth of new connective tissue. (Figs. 319 and 320.)

In fractures in the dorsal region the bone displacement is usually extreme and the cord lesion consequently severe.

SYMPTOMS OF FRACTURES OF THE SPINE IN GENERAL.

Thorburn* contributed much to the accuracy of our knowledge of the symptomatology of this class of injuries. He stated, in the brochure referred to, that in the near future surgeons would open the spinal canal with as little danger and as little hesitation as they then operated upon the cavity of the cranium. Much has been done toward the fulfilment of this prophesy. Burrell* has divided the cases into three groups: (1) those in which the cord is crushed; (2) those in which doubt exists as to whether the cord is irremediably damaged; and (3) those in which it is fair to assume that the cord is not irremediably damaged. In a series of two hundred and forty-four cases, he reports the following frequency of the different symptoms:—

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* Thorburn: "A Contribution to the Surgery of the Spinal Cord," 1889.

FREQUENCY OF SYMPTOMS. TOTAL CASES, 244.

Crepitus	93 = 37.8%		Paralysis, none	16 = 11.1%	
Deformity	159 = 68.1%		Pain	171 = 74.8%	
Unconsciousness	41 = 17.6%		Priapism	66	
Paralysis, complete	185 = 71.7%		Delirium	43 = 11.7%	
Paralysis, partial	27 = 11.3%		Cystitis	66 = 28.0%	
		Bed-sores	63 = 26.6%		

Walton† states that fracture of the spine, with complete transverse lesion of the cord, is accompanied by immediate relaxed motor paralysis involving the parts below the level of the lesion. There is entire absence of rigidity, of spasm, of convulsive movement, or of other signs of irritation, in the motor sphere. The statement that signs of motor irritation may appear at the level of the lesion seems based rather upon theoretical considerations than upon practical observations. Where the cord is partially injured, or where hemorrhage is taking place, there is a slower onset of paralysis, with a unilateral or irregular distribution affecting the arms, for example, more than the legs, and evidenced by preser-

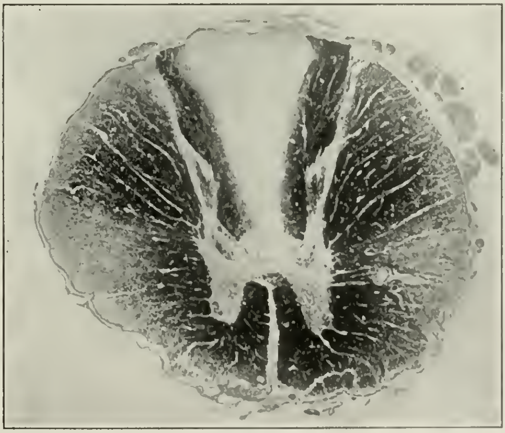

FIG. 320. Section of Spinal Cord in Mid-thoracic Region, showing intense degeneration of the columns of Goll and also some degeneration in the direct cerebellar and Gowers' tracts. (Allen: "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

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* Burrell, in Annals of Surgery, Oct., 1905.

† Walton, in Jour. Nerv. and Ment. Disease, vol. xxix., 1902, 1.

vation or comparative preservation of the reflexes and by rapid improvement. As an aid toward reaching a correct diagnosis as to the level of the lesion, the tables which were worked out by Thorburn,* and which are based on clinical rather than on anatomical or experimental knowledge, have stood the test well.

Lloyd † says that, where the fracture has produced a total transverse lesion of the cord, the area of anæsthesia is generally sharply marked, and does not extend beyond a level corresponding to the segment crushed,—that is, a level materially below the seat of the lesion. Incomplete anæsthesia points to incomplete lesion of the cord. This is true also where the anæsthesia is limited or is of unilateral distribution. In the cervical region, for example, the injury done may be limited to a certain amount of bruising and stretching of the nerve roots, perhaps with temporary displacement of vertebræ and rupture of ligaments. Retention rather than incontinence of urine is the rule in all varieties of spinal fracture which are associated with injury to the cord, even when the lesion involves the lumbar region. There may be either retention or incontinence of fæces, more often the former. When the lesion of the cord is incomplete the sensation in the rectum and bladder may be preserved, even though voluntary evacuation is impossible. The symptoms referable to vaso-motor disturbance are variable and baffling. The phenomenon most commonly observed is a rise in the superficial temperature of the lower extremities, which may be replaced later by coolness of the extremities and sometimes by marked coldness. The skin is generally dry. Sweating is absent. The knee jerk is lost in cases of com-

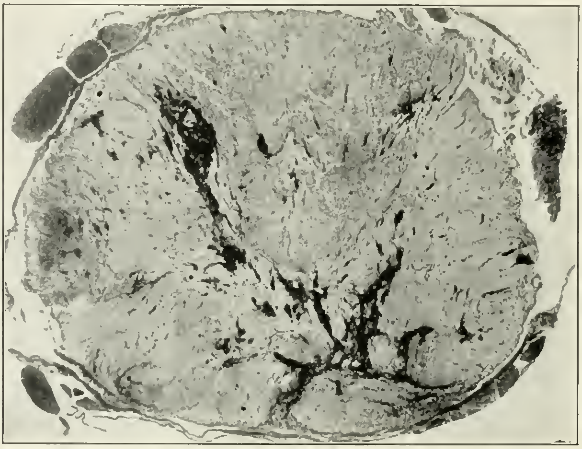

Fig. 321.—A Section of the Spinal Cord at the First Thoracic Segment, showing intense hemorrhagic condition. (Allen: "Injuries to the Spinal Cord," in *Jour. A. M. A.*, March 21st, 1908.)

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* *Op. cit.*

† Lloyd, in Med. Rec., March 23d, 1907.

plete destruction of the cord. The superficial reflexes are also generally lost or diminished in these cases. This may not necessarily be limited to the reflexes below the lesion, but may involve those higher up. The Babinski reflex may appear when no other reflex is present. Lloyd says that, when these data are at hand, we can form some fairly definite conclusion with regard to the condition of the cord,—whether there is a complete or an incomplete destruction. In the former case it is useless to operate; in the latter it becomes necessary to consider at what time the operation can best be performed.

Thomas* gives a list of the factors which would justify us in concluding that there is a complete transverse lesion of the cord. They are as follows:—"(1) complete paralysis, usually of a flaccid type; (2) a complete loss of sensation in all its forms; (3) absent reflexes, especially the knee jerk, while the plantar reflex, on the contrary, is often retained; (4) complete paralysis of the bladder and rectum, with priapism; (5) vaso-motor paralysis, with copious sweating in the paralyzed parts; (6) and most important, absence of variations in symptoms; (7) absence of irritative phenomena, such as pain."

Regional Frequency.—The great majority of cases of traumatic spinal paralysis are either of cervical type or of lumbo-sacral type; the latter including the cauda equina. It is possible that there may have been observed at the bedside not a few cases in which the bone lesions were not recognized and in which the cord symptoms were so slight as to escape identification. If this be true, it is fair to assume that, in actual numbers, the cervical and the lumbar cases would more nearly approach equality. In Burrell's report of two hundred and forty-four cases, the following regional frequency was discovered:—

REGIONS.		TOTAL CASES, 244.	
Cervical..	86 = 33.9%	Deaths	77 = 85.7%
		Recoveries..	9 = 14.3%
Upper dorsal...	43 = 16.7%	Deaths...	37 = 76.7%
		Recoveries...	10 = 23.3%
Lower dorsal...	75 = 32.9%	Deaths...	41 = 56.1%
		Recoveries...	34 = 43.9%
Lumbar.........	40 = 16.3%	Deaths...	20 = 50.0%
		Recoveries...	20 = 50.0%

TREATMENT OF FRACTURES OF THE SPINE IN GENERAL.

The treatment of injuries of the spine presents many interesting problems. In practice the surgeon is confronted with cases in which the spine has been damaged, with or without concomitant injury to the spinal cord. If the injury involves the spine alone, the treatment is much simpler than where it is associated with lesions of the spinal cord. The treatment may be conveniently discussed under the following heads:—(1) Expectant treatment; (2) Reduction and fixation of the bony parts; (3) Primary laminectomy, and (4) Secondary laminectomy.

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* Thomas, in Boston City Hosp. Med. and Surg. Rep., 1900.

The selection of the kind of treatment should depend on what injury to the cord exists or what injury to the cord is likely to occur.

(1) *Expectant Treatment.*—Expectant treatment is applicable to fractures of the spinous processes, or even of other bony structures, where there are no cord symptoms. It consists of keeping the patient fixed in bed on a Bradford frame (Vol. IV., page 961), and of employing very careful methods of nursing. The use of water and air mattresses and sandbags aids very much in preventing bed-sores.

(2) *Reduction and Fixation of the Dislocated Parts.*—Reduction and fixation should be employed after a careful examination has been made to determine the location and extent of the injury. During this examination great care should be used to prevent further displacement and possible injury to the spinal cord. Correction should then be attempted very slowly, the patient being kept as far as possible in the axis of the spinal column and a note being made, at each step, of the condition of the cord, as shown by sensation, motion, and the state of the reflexes. On the appearance of the slightest evidence that the cord is being injured, the effort should stop. As soon as the deformity has been corrected, a plaster jacket should be applied while the body is suspended or while it is supported in a horizontal hammock, enough hyperextension being used to open the narrowed canal to its normal limit. Burrell, in 1887, reported sixteen cases which had been treated by fixation after immediate rectification. The results obtained were as follows:—Three of the patients died, three received no benefit, and ten were greatly improved. Immediate operation is not favored by the majority of surgeons for two reasons: first, that an injury, which involved destruction of the cord, has already been inflicted and will get no worse in the course of a few hours; and, second, that the patient is still suffering from spinal and general shock. Burrell, on the other hand, advocates an immediate operation unless shock is present, stating as a reason for this that no one can positively tell in what condition the spinal cord is until he actually inspects this structure at the site of the injury. Then, if it is found that pressure is being exerted upon the cord, it is plain that a continuance of this pressure for many hours will inflict irreparable damage upon the organ. Walton and Lloyd also believe that there is danger in delaying operation in the cases which have recovered from their first shock and which have in them anything objectively hopeful. Lloyd, however, says that it is evident that, if we operate immediately after the injury, we shall have failures that should not rightly be charged to the operation itself. He believes, therefore, that it would be better, if possible, to wait until the question can be settled whether the patient will overcome the shock or will succumb directly to the effects of the injury. Another objection to immediate operation is that paralysis and anaesthesia may result from so-called concussion of the spine. It is impossible, too, in the first few hours, to determine with any degree of certainty how severe the injury really is; nor can it, as a rule, be definitely localized. It is the consensus of opinion, therefore, that the surgeon should wait until the period of shock has passed, and until it is evident that a spontaneous recovery, complete enough to render life endurable to

the patient, may not reasonably be expected. The conditions which justify the operation of laminectomy for spinal-cord injuries are the following: (1) the existence of pressure exerted by the posterior arch of a vertebra or only by a spicule of bone; (2) the presence of blood clots and the continuance of hemorrhage in the spinal canal; (3) the existence of traumatic œdema of the cord, and (4) the presence of septic conditions of the cord, in both of which the establishment of drainage is urgently needed.

GENERAL PROGNOSIS IN FRACTURES OF THE SPINE.

Lloyd* states that he has performed laminectomy in thirty-two cases, some of which have improved to a marked degree, while many others have shown absolutely no benefit from the operation. In the two hundred and forty-four cases collected by Burrell,—cases which were taken indiscriminately from the published records of the period from 1864 to 1905,—the following statistics as to mortality and recovery were established:

MORTALITY.

Total cases, 244.
Deaths ....171 = 64.5%
Recoveries......73 = 35.5%

TIME.

Total cases, 244.
Total deaths...171 = 64.5%
Within 5 days..117 = 65.7%
Within 10 days..16 = 8.6%
Within 1 month..18 = 12.1%
After 1 month...20 = 13.3%

RESULTS.

Total cases, 244.
Total recoveries..73 = 35.5%
Useful .... 47 = 62.2%
Useless ....26 = 37.8%

To make clear the results of operation, Lloyd† published the following table of laminectomies in 1902:—

LLOYD'S STATISTICS OF LAMINECTOMIES.

Cervical Region.	*Immediate Operation.*	*Later Operation.*	*Lumbar Region.*	*Immediate Operation.*	*Later Operation.*
Deaths.............	21	2	Deaths...........	4	4
Recovery...........	0	2	Recovery..	1	6
Improved.........	2	1	Improvement.......	1	6
Not improved......	0	4	No improvement..	0	4
Subsequent death...	4	3	Subsequent death...	0	2
	—	—		—	—
	27	12		6	22

Dorsal Region.	*Immediate Operation.*	*Later Operation.*	*Sacral Region.*	*Immediate Operation.*	*Later Operation.*
Deaths.............	23	5	Deaths. ...	0	0
Recovery...........	4	10	Recovery.........	0	1
Improved...........	9	18	Improved	0	3
Not improved.......	6	16	Not improved.....	0	0
Subsequent death....	7	16	Subsequent death...	0	0
	—	—		—	—
	49	65		0	4

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* Lloyd, in Med. Rec., March 23d, 1907.

† Lloyd: "The Surgery of the Spine." Med. Jour., Feb. 22d, 1902, p. 374.

From these statistical statements we are justified in drawing the following conclusions: (1) that, if pressure on the cord is allowed to remain for many hours, irreparable damage to its component structures is likely to take place; (2) that, unless it is perfectly clear that the cord is irremediably damaged, an open operation to establish the condition of the cord and to relieve pressure is imperative as soon as surgical shock has been recovered from; (3) that, in certain cases of fracture of the spine, when the cord is not injured but is liable to injury from displacement of the fragments of a vertebra, rectification of the deformity and fixation of the spine is a proper procedure; and (4) that, if the cord is crushed, no matter what treatment is adopted, there will of necessity be a high rate of mortality. The cases in which the fracture of the spine is not accompanied by marked cord symptoms present a much more hopeful outlook, as witness the series of cases reported by Burrell.* On the other hand, the cases in which the cord is crushed present lesions of such a character that one cannot reasonably expect recovery to follow treatment of any kind. The following autopsy reports, taken from the pathological department of the Boston City Hospital, show how serious are these lesions in certain cases:—

(*First Case*)—"Arches of spinous processes of first and second dorsal vertebræ absent (removed by operation). Cord at this point appears normal. No blood in spinal canal. On anterior aspect of spinal column, fifth cervical projects anteriorly 5 cm. in front of cord, which is dislocated backward. Fourth is freely movable on fifth, and also fifth to a somewhat less degree on sixth. Body of sixth anteriorly is movable with crepitus, and spinous processes with a portion of arch of this same vertebra can also be moved freely from side to side. There is apparently fracture of transverse processes of fifth cervical vertebra.

(*Second Case*)—"Examination of spinal column from anterior surface showed transverse fracture of body of seventh cervical vertebra. Small bony fragments projected into adjacent tissue. Arches of sixth and seventh cervical were comminuted. On posterior surface of dura, beneath arch of seventh cervical and to less extent beneath that of sixth, was a small amount of dark-red coagulated blood. No hemorrhage within dura. Vessels on surface of cord were injected. Distinct softening of cord opposite point where sixth nerve is given off.

(*Third Case*)—"Spines of seventh and eighth dorsal vertebræ are not present. Opposite the bodies of seventh and eighth the cord is sharply compressed by knuckle from posterior portion of bodies. When the dura was opened the cord was found completely divided, the upper portion being separated from lower by space 4 cm. wide. The torn ends of cord end blindly in mass of fibrous tissue. Body of eighth dorsal was seen to have been forcibly driven backward and crushed between seventh and ninth dorsal. Lower portion of ninth exhibited old line of fracture with new formation of bone at about middle of body. No evidence of articular cartilage between eighth and ninth dorsal. Ninth projected into spinal canal at a sharp angle, about forty-five degrees. Above angle made by displaced ninth there was a new growth of bone along front of spinal canal, making angle less prominent."

The writer's personal experience with the operation of laminectomy is limited to seven cases, in which the injuries were of a severe character, and in all of these he failed to save the patient's life.

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* Burrell, H. L., in Annals of Surgery, Oct., 1905.

As to the question of regeneration of the spinal cord, the literature contains a number of trustworthy reports of cases in which such regeneration undoubtedly took place. The following statements are quoted from Lloyd's article:*

"Thomas† has examined the cord microscopically in several cases dying within a few days of the accident, and he emphasizes the fact that hemorrhagic conditions exist, as well as marked degenerative changes of the cord itself, for a considerable distance beyond the actual crush. He calls attention to the fact that sensory and paralytic symptoms are of the greatest value for the diagnosis and the location of the injury to the cord, but that the injury is apt to be even higher than the symptoms would indicate. This bears out a suggestion which I made in a former paper with regard to the necessity for the surgeon to carry his exploration farther than the involved segment, and it also suggests the possibility of a marked improvement in the symptoms, with an absorption of these minute hemorrhagic areas, as I suggested in a discussion before the New York Academy of Medicine last year.

"Weissman's dictum that nerve cells once destroyed are never replaced seems to be true, although some observations, notably those of Worcester and the reports of several operators on the spine, would seem to prove the contrary. Barker‡ says: 'Regeneration of severed nerve fibres within the spinal cord and brain is unfortunately very much less complete than in the peripheral regions.' Oliver§ says: that 'sufficient regeneration of nervous tissue to carry on the functions of the spinal cord does not occur, and no method is at present known by which these functions may be restored.'

"Dr. L. Pierce Clark ‖ concludes that animal experiments fail to provide data that show beyond a doubt that central tracts of the nervous system are ever regenerated to such an extent that the former function is restored. In warm-blooded animals, and in the human species in particular, an abortive attempt on the part of the cord to reproduce its component elements is largely, if not solely, confined to fibres of undoubted peripheral type. Histological analyses of cases of hemisection, compression paraplegia, myelitis, and other like destructive lesions of the cord, fail to show positive evidence that actual structural regeneration of axis cylinders ever occurs in the central nerve tracts of the human spinal cord. In case of complete division of the brain and spinal tracts, there is simply degeneration followed by sclerosis. A most acceptable reason for nonregeneration of such tracts was shown in the fact that the component nerve fibres do not possess a neurilemma sheath, from which nerve regeneration mainly if not solely occurs. This lack in the cord and brain tracts, as contrasted with the regenerating power possessed by peripheral nerves, was due possibly to a difference of embryological origin for the two structures of the nervous system.

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* Lloyd, in Med. Rec., March 23d, 1907.

† Thomas, in Med. and Surg. Reports of the Boston City Hospital, 11th series. Boston, 1900.

‡ Barker: "The Nervous System," p. 246.

§ Oliver, in Annals of Surgery, vol. xxxvii., 1903, p. 239.

‖ Clark, in Medical Record, Sept. 8th, 1906, p. 575.

The seven cases cited by Stewart and Hart, in which the regeneration of the cord took place after simply a hemisection, either do not fulfil the conditions required in such a test, or they do not furnish sufficiently definite and convincing evidence that regeneration actually occurred. In cases of complete transverse division of the cord,—cases in which the cord was divided for experimental purposes or in which the division was observed in the course of clinical experience, —the results noted were not of such a nature as to warrant suturing of the spinal cord in an attempt to cure the defect."

III. NON-TUBERCULOUS AFFECTIONS OF THE SPINE.*

Aside from tuberculous ostitis of the spine, there are several affections which are capable of producing distortions of the vertebral column. These may be roughly divided into two classes: those which are attended by angular deformity, and those which are attended by a simple bending of the spinal column. The cases which belong to the first class present conditions very similar to those resulting from Pott's disease, and, on the whole, the treatment which they require is very similar to that employed in the latter disease.

Actinomycosis of the Spine.—This disease is due to the action of the ray fungus. When it occurs in the spine, it is secondary to actinomycotic disease elsewhere, and is usually insignificant as compared with the principal lesions. It is an extremely rare disease in this part of the body, and needs only to be mentioned as a possibility. The process, in its advance, rapidly reaches the vertebral canal and excites there a pachymeningitis. In a few cases it has produced marked destruction of the vertebral bodies.

For the diagnosis, symptomatology, and treatment, see Vol. II., p. 55 *et seq.*

Acute Osteomyelitis of the Spine.—Three degrees of this affection are recognizable, according to Tubby.† They are as follows: a comparatively mild form, a form of moderate severity, and a severe form. (1) In the mild form the inflammation of the periosteum produces a certain amount of thickening and then subsides without apparently causing denudation of the bone. Ultimately, too, it leaves the spine in a practically healthy condition. (2) In the moderately severe form the periosteum and the superficial layers of the bone are involved, and considerable inflammatory softening takes place. Suppuration may or may not occur, but in any event a certain amount of deformity is sure to be the result. (3) In the severe form of the disease the bodies of the vertebræ are the sites of numerous purulent foci, or the neural arches and processes are bared and necrosed. This form goes on to suppurative inflammation of the spinal membranes and medulla, and is very likely to terminate fatally.

SYMPTOMS.—The symptoms are similar to those of an acute infectious process—*i.e.*, there is a sudden onset, and the disease is characterized by pain, elevation of temperature, and constitutional disturbance. Although the disease occurs most commonly in growing individuals, it is also observed in adult life. Makins and Abbott report a case which occurred at the age of forty-six years. Males are more liable to the affection than females, the proportion in the cases reported being two to one. Local symptoms are tenderness about the spine, stiffness at the area affected, and, in the milder forms, subacute spinal inflammation. In the cases of a more violent type, there are early signs of general septic intoxication, rapidly deepening in intensity; and, unless the pus be evacuated, death is likely to follow, from exhaustion, from metastatic deposits, or from meningitic and myelitic complications. In all cases, there are agonizing pain, when any attempt is made to move the patient, and marbling and distention of the superficial veins.

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* The subject of tuberculosis of the vertebral column has been exhaustively treated by Dr. Clarence L. Starr in vol. iv., and will therefore not receive consideration in this article.

† Tubby, in Brit. Med. Jour., Sept. 30th, 1905.

Diagnosis.—The importance of an early diagnosis is very great, for by early recognition and treatment only is it possible to save life. The history of sudden onset, the rigidity of the spine, synchronous with the onset, the early appearance of nerve symptoms, complaints of agonizing pain in the back, and the rapid development of serious general illness, all point to the presence of this affection. In certain cases a diagnosis has been established by means of the Roentgen ray. Warren records a case where an abscess was discovered between the second and third cervical vertebræ.

Regions of the Spine Affected.—All parts of the spine have been involved, with the exception of the coccyx. Of the three regions,—lumbar, dorsal, and cervical,—the lumbar region is the most frequent seat; next the cervical; and last the dorsal area. The violent form of infection is usually limited to one vertebra; the milder forms may affect several vertebræ at the same time.

Prognosis.—In the milder types, where the infection involves simply the periosteum, the prognosis is favorable; but in the severe type the mortality rate is high. Hunt* has placed it at not less than fifty per cent; Tubby places it at seventy-five per cent. Of the twenty-one cases reported by Makins and Abbott, fifteen were fatal. Riese reports four cases, with one death. Of the forty-three cases collected by Hahn, twenty-six were fatal.

Treatment.—The milder forms are best treated by rest in a recumbent position, and afterward by the application of some form of support. The severe cases demand immediate operation and evacuation of the pus. This is best done by laminectomy or by costo-transversectomy; the latter operation, as recommended by Menard, affording the best means of arriving at the seat of pus formation.

Costo-Transversectomy.—By this operation we are enabled to reach and evacuate abscesses (generally tuberculous) and remove dead bone from the body of a thoracic vertebra, by resecting one of its transverse processes and the spinal end of its attached rib. An imaginary line having been drawn through the tips of the spinous processes, in the vicinity of the focus of the disease, an incision at least four inches in length is made at a distance of about one inch and a half from the line referred to above, and parallel with it. This incision is carried through the skin and muscles down to the bone, so as to expose perfectly the angle of the rib and the transverse process. The bone should now be cautiously freed from the soft parts, care being taken to avoid injuring the intercostal arteries and nerves. The bones should then be removed with the rongeur, bone pliers, or Gigli saw. Pointed forceps are now forced into the abscess cavity, the opening is enlarged by withdrawing the opened forceps, and the dead tissues are removed, care being taken not to open into the posterior mediastinum. The cavity should be treated as an open wound.

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* J. R. Hunt, in N. Y. Med. Record, April 23d, 1904.

The Rhachitic Spine.—The rhachitic spine is a deformity caused by rhachitis. According to Whitman, there is observed in infancy a long posterior curvature of the spine, due to the fact that it is lacking in rigidity. During the subacute stage of general rhachitis, the child that has never walked sits most of its time in a chair, or is held in the mother's arms, and as a result the spine is bent backward, and this abnormal curvature of the vertebral column in the lower thoracic and lumbar regions eventually becomes habitual. It develops during the first or second year of life, and gradually becomes more noticeable; in course of time it will be found to persist even when the child is lying down. There is nothing angular about this distortion, and placing the patient in a prone posture will usually reduce it. The pain of acute rhachitis is general, and is easily explained by the sensitive condition of the bones and joints.

Diagnosis.—The principal symptoms of general rhachitis should enable one to distinguish this condition from Pott's disease. It is possible that the two conditions may coexist, but in such a case the symptoms, both general and local, would be so severe that little difficulty would be encountered in distinguishing between the two.

Treatment.—The treatment should be both general and local. The general health should be built up by measures which will improve the nutrition of muscles and bones. Locally, the indications are to overcome the rigidity and limit the motions of the spine, to support it during the stage of weakness, and to remove the predisposing cause. The deformity may be corrected by massage and direct manipulation of the spine. Daily the child should be placed face downward on a table and the spine slowly hyperextended, these movements being followed by thorough massage of the muscles. Severe cases should be kept in a recumbent posture for several months. Older subjects should wear a light back-brace, and should exercise daily, with a view to the correction of the deformity.

A natural cure often takes place in these cases, but it is rather a distribution of deformity than a correction of the same. The exaggerated dorsal kyphos often produces a marked lordosis, known as the "rhachitic attitude."

Syphilis of the Spine.—Syphilis of the spine starts in the periosteum, as a rule, but may originate in the bone. It is seen in both the inherited and the acquired forms. It develops into a gummatous caries, and usually affects the upper vertebræ, although it has also been seen in the lower. It is a very rare affection. The congenital form, from a surgical standpoint, is insignificant. The acquired form is encountered only in the tertiary stage of the general disease. It does not make its appearance in the spine until years after the initial infection. Teissier has reported a case where the tertiary lesions, which developed in the pharyngeal wall, extended to the bodies of the vertebræ. Autenrieth has reported a case where the dura, owing to the destruction of the arch of the atlas and the odontoid process of the axis, could be seen through the mouth.

Diagnosis.—Where syphilis is limited to the spine, it is exceedingly difficult to differentiate it from Pott's disease. The clinical picture is identical with that presented by tuberculous caries. There are local pain, kyphosis, and cord-symptoms, but rarely abscess formation. In lesions involving the cervical portion of the spine the difficulty of swallowing and breathing suggests retropharyngeal abscess. The bone destruction may be very extensive, and the deformity may appear suddenly, as a result of trauma, which may, indeed, fracture the spine at the seat of the disease. Fischer and Wade have reported cases where the arch of the atlas has been cast off into the mouth. The diagnosis depends on the history of specific infection, and cannot be positively made without instituting antisyphilitic treatment. This should be done with care, however, as potassium iodide has proved disastrous in cases of tuberculosis. The development of exostoses and of deposits of bone elsewhere, either in the interior of the bones or in the region of the periosteum, save these cases from the serious after-effects which might justly be supposed to follow so great a destruction.

Treatment.—Potassium iodide should be administered daily, as in the ordinary treatment of syphilitic lesions elsewhere. Orthopedic measures should be instituted to prevent deformity and to protect the weakened spine. The treatment, aside from the medicinal treatment of syphilis, should differ in no respect from that instituted in cases of Pott's disease. (See article "Tuberculosis of Vertebral Column," in Vol. IV.)

Infectious Arthritis of the Spine.—During the progress of the disease or during convalescence, in the case of certain infectious diseases, there may appear symptoms which point quite distinctly to the fact that some change is going on either in the vertebræ themselves or in the immediately surrounding tissues. The list of infectious diseases which may be followed by definite changes in the spine is a long one. It includes typhoid, paratyphoid, gonorrhœa, measles, scarlet fever, influenza, septicæmia, pyæmia, pneumonia, and pustular acne. To this list may be added purpura, scurvy, and acute rheumatic fever. The exact pathology of the alterations in the vertebral column which follow these infectious diseases is not definitely known. The condition is probably due to a secondary infection of the fibrous covering and attachments of the spine. Arthritis of the vertebral joints is a possibility; and yet the process may be an ostitis, an osteomyelitis, a chondritis, a perichondritis, a periostitis, or any combination of these affections.

Typhoid Spondylitis.—After typhoid fever, or during its course, the patient may develop a painful affection of the spine, which, according to Gibney,* is an acute inflammation affecting the periosteum and the fibrous structures which hold the spine together. The possibility of the affection being an arthritis should be considered. (See Figs. 322 and 323.)

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* Gibney in Trans. of Amer. Orthop. Assoc., 1889.

The frequency of spinal symptoms in typhoid fever is greater than was formerly supposed. During the last few years a considerable number of cases have been reported. Convalescence is the period at which the symptoms usually manifest themselves. Males are three times as liable to the affection as females. According to Fluss,* who collected forty-six cases from the literature, trauma acted as a factor in but a few instances, and in the majority the typhoid was of mild grade.

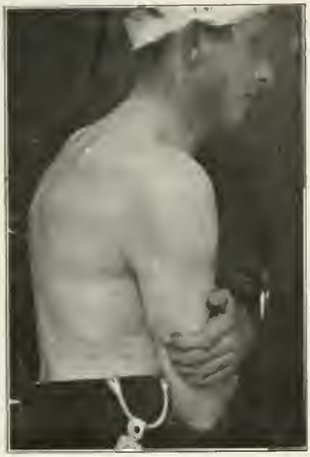

FIG. 322. Profile View of Typhoid Spine. (Author's case.)

The principal symptom is pain, which is referred to the lower dorsal or lumbar region and is increased by either active or passive movement. In many cases, neurotic symptoms are strongly marked, the patient becoming hysterical and losing control over his inhibition. Swelling of the soft parts and local redness were noted in but five of the forty-six cases collected by Fluss. There are very often tenderness on pressure and deformity, either a kyphosis or a scoliosis.

Some patients have recovered in the course of two weeks, while others have suffered throughout a period of two years. In the majority of cases the symptoms tend to disappear with remarkable rapidity.

Recumbency during the active stage and the administration of sedatives constitute the best treatment. The Paquelin cautery has been used with benefit. On getting about, the patient should wear some form of spinal support, either a jacket or a back-brace, for a considerable period after the disappearance of active symptoms.

McCrae† in an article on "Typhoid Spondylitis," concludes that in certain instances there are definite changes in the bony vertebræ; that the general features of the condition suggest the probability that in most cases organic changes take place in the spine; and that the similarity between the changes found in typhoid spondylitis and those found in the spondylitis that accompanies other affections (especially arthritis deformans) renders it not unlikely that this latter disease may be due to various infective agents.

Gonorrhœal Spine.—Gonorrhœal rheumatism of the spine is a definite affection, and many cases have been reported which were unmistakably of this nature. The affection is rare, according to some authors, but Rendu believes that it is relatively common. Doubtless many cases have escaped identification and have later been diagnosticated as various forms of spondylitis deformans.

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* Fluss, in Centralbl. f. d. Grenzgeb. der Med. u. Chir., Bd. viii., pp. 17–22, 1905.

† McCrae, Am. Jour. Med. Sc., Dec., 1906; and Silver, in Am. Jour. Orth. Surg., Oct., 1907.

The case cited by Marie* has been endorsed by many as presenting a typical picture of this form of spinal rigidity. The patient was a man aged thirty. After repeated attacks of gonorrhœa, he developed a tibio-tarsal arthritis. Soon afterward, pain appeared in the cervical region of his spine. One year later, the spine in the cervical region was practically rigid, and the muscles about the neck were œdematous and lardaceous. Bradford has reported two cases which are also typical, but the affection in one case did not begin in the cervical vertebræ—its usual starting-point. Raymond† has reported a case in which the affection was localized in the sacro-iliac synchondrosis. The cervical region has been that most frequently affected in the cases reported. The disease is ushered in by pain, with weakness and stiffness of the back or the neck. The inflammation is of a subacute nature, and does not cause severe general symptoms, though the temperature, as a rule, is elevated. Finally, the acute symptoms disappear, and the spine is left ankylosed to a greater or less degree.

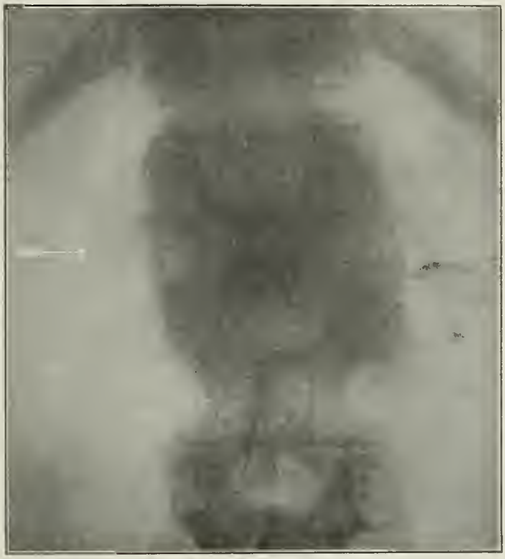

Fig. 323. Typhoid Spine. The radiogram shows the limitation of the process to the region of the disc, and the deposit of new bone (indicated by arrow), between the transverse processes. (Original.)

The diagnosis depends on the history and on the fact that the spine is involved in a low-grade inflammatory process.

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* Marie, in Revue de Méd., No. 18, 1898, p. 285.

† Raymond, in Semaine Méd., No. 1, March, 1899.

In order to prevent deformity the spine should be supported, and, where the sensitiveness is severe, the patient should be kept in the recumbent posture. At a later date local massage and exercise will be found useful.

Arthritis of the Spine.—After certain infectious diseases, such as tonsillitis, diphtheria, etc., the smaller joints, especially in the occipito-axoid region, become affected by a form of acute infectious arthritis similar in its manifestations to rheumatism. The acute onset of this form of stiff-neck will usually help to differentiate it from tuberculous disease or from acute torticollis, although the appearance of the individual and the rigidity of the neck would suggest either of these conditions.

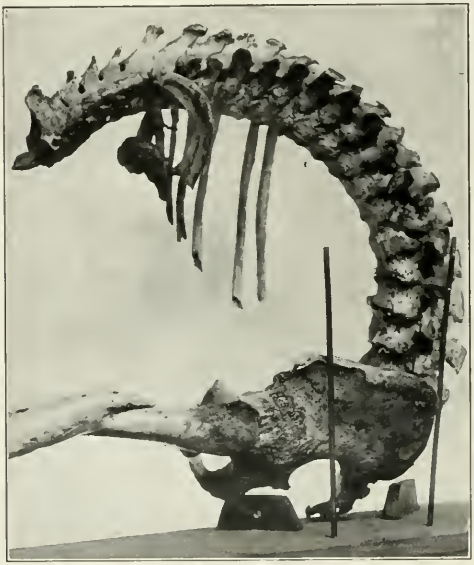

Fig. 324. Arthritis Deformans (Spondylose Rhizomélique). Involvement of the entire spinal column with complete ankylosis; also ankylosis of the hip-joint. (Museum specimen in the Medical Department of Washington University, St. Louis, Mo.)

Support, if kept up for a few days, will relieve these cases entirely of pain. The Thomas collar affords the best means of furnishing the needed support. After the severe symptoms have disappeared, massage and exercise will complete the cure.

Rigidity of the Spine.—In 1867 Virchow divided all the cases which are characterized by a rigid spine, with or without deformity, and which are accompanied by symptoms of a subacute or acute character, or by no symptoms at all, into two classes: one in which a bridge of bone forms between adjacent vertebral bodies, following a loss of intervertebral substance and degeneration of the tissues; and a second in which the ligaments about the spine undergo ossification, thus producing a condition of ankylosis. These two classes were called Arthritis Deformans and Osteo-Arthritis, and they remained in the literature as disease entities till Beeterew * (1892) and Marie (1898) began investigations which have led to the publication of many monographs on the subject by different observers. Many new names, which in reality describe only a very few clinical entities, have been added to the literature. In order to diminish, if possible, the confusion which has thus been created, we shall use Elliott's classification (1905), which is based on the study of fifty-one cases of spinal rigidity.

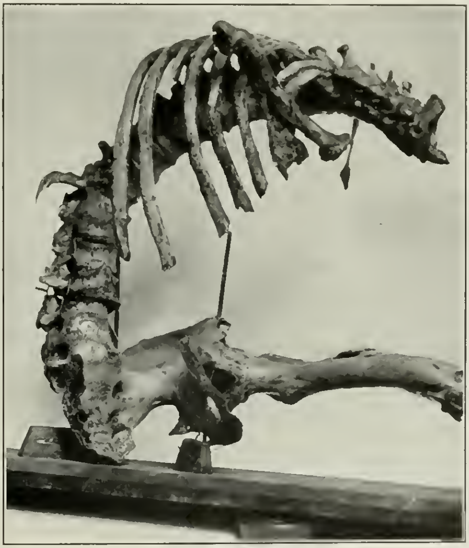

FIG. 325.—Another View of the Spinal Column Shown in Fig. 324.

(1) *Ostitis Deformans, or Spondylitis Deformans.*—This affection, which is defined by Elliott † as a painless, deforming, passive, osteophytic, new formation of bone, secondarily produced and degenerative in character, has a subacute symptomatology, and seems to be the result of age degeneration, or of secondary changes. Exostoses of the vertebræ constitute the predominating lesions. They grow out from one vertebral body and unite with a similar outgrowth upon an adjoining vertebra, thus making a series of hard bony bridges between the bodies. This process involves only a part of the spine. Simmons,‡ in a study of three hundred cases with the aid of the *x*-ray, states that the entire vertebral

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* Beeterew, in Neurolog. Centralbl., No. 18, 1898, p. 285.

† Elliott, in Am. Jour. Orthop. Surg., 1906.

‡ Simmons, in Fortsch. a. d. Gebiete der Roent. Strah., No. 7, 1903.

column is never involved at the same time. The formation of exostoses may involve the head of the rib, and may at times be incomplete between the vertebral bodies. The anterior common ligament is not the seat of this ossification, as the process always occurs on one or the other side of the vertebral bodies—far more frequently on the right; a fact which is attributed by Simmons to the habitual use of the right side. (Fig. 330.) The spine presents the appearance of having had a soldering mass poured over the antero-lateral surfaces of the vertebral bodies, which mass, as if under the influence of gravity, had flowed downward and had become hardened.

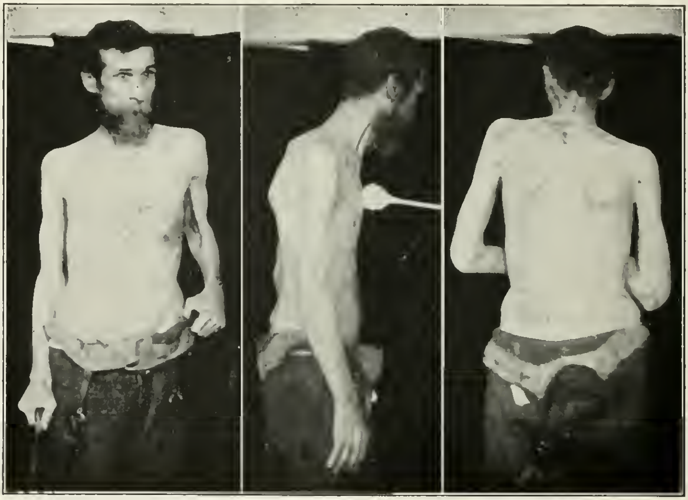

Fig. 326.—A Case of Ankylosis of the Spine (Chronic Ankylotic Rigidity); front, side, and rear views. (Hunter: *Glasgow Med. Jour.*, March, 1907.)

Advanced age, arteriosclerosis, traumatism, and occupations that have occasioned constant spinal exertion and exposure, are the more common etiological factors. The principal symptoms are: an abnormal attitude, either that of scoliosis or that of a long dorsal kyphosis; at times a back that is flattened and board-like; rigidity of the vertebral column; and limited power of moving the trunk. Pain is a rare symptom. In many of these cases the discovery of the true condition is first made at the autopsy, the individuals themselves never having complained of their backs during their lifetime.

When the condition is discovered, support and protection of the spine and change of occupation are indicated.

(2) *Chronic Ankylosing Inflammation of the Spine.*—This affection is characterized by increasing vertebral rigidity, with or without root symptoms, and is often accompanied by involvement of one or more of the large and small joints

of the extremities. The tendency is toward complete bony ankylosis of the vertebral column. (Elliott.) The affection is common among the young and the middle-aged.

Marie states that pain of a radiating character, following the course of the intercostal nerve, is the initial system. This pain is usually increased with any change of position, and is at times severe. Undoubtedly cases have been observed where there was deformity, and where stiffness and deformity both developed without pain. These instances, which are certainly of rare occurrence, may be regarded as variations.

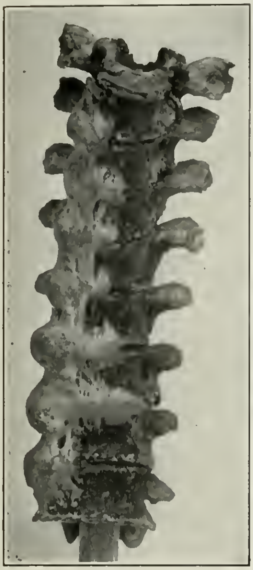

Fig. 327.

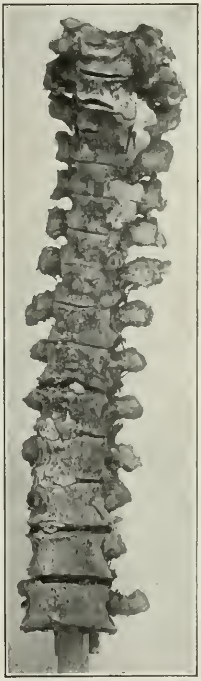

Fig. 328.

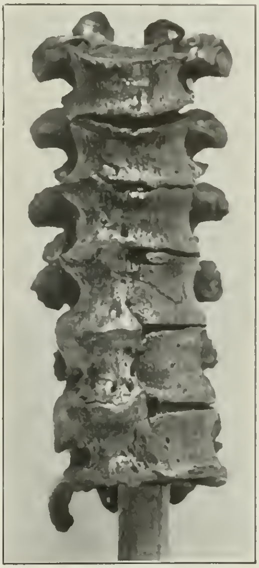

Fig. 329.

Figs. 327, 328, and 329.—Chronic Ankylotic Spinal Rigidity, with exostoses which form a bond of union between the vertebral bodies. (Museum specimens in the Medical Department of Washington University, St. Louis, Mo.)

Early rheumatic affections are of undoubted influence as etiological factors. In Elliott's compilation, as many as one-half of the patients showed positive evidence of rheumatism having preceded the onset. Gonorrhœa and syphilis have, in several cases, been associated with the establishment of this disease. Trauma of an indirect or long-continued nature has been referred to by Baeumler as a cause. The carrying of loads on the back is cited by Reuter as a factor. Marie* states that this disease is primarily an infectious process or a process of a toxic nature, difficult to distinguish in its etiology from any other form of chronic rheumatism.

The pathological changes consist in ossification of the small joints and ligaments of the spine, and in the formation of slight or extensive exostoses which unite to form bridges between the vertebræ. The intervertebral discs are small and shrunken in front; the long ligaments of the spine do not tend to ossify; the articular processes grow together; the joints between the ribs and vertebral bodies, and between the ribs and transverse processes, are completely ankylosed, producing a general picture of bony ankylosis of the entire spine. These pathological changes, according to Siven,† appear primarily in the small joints of the spine, and develop symmetrically.

There are several different types of this affection, namely: Osteoarthritis of the spine; the Becterew type; spondylose rhizomélique; and cyphose hérédotraumatique.

Osteoarthritis of the Spine. (Goldthwaite,‡ 1899.)—According to this writer, osteoarthritis of the spine is an affection which is characterized by hypertrophic changes at the edges of the intervertebral cartilages, together with atrophy of the discs, absorption to some extent of the vertebral bodies, and complete ankylosis of the spine as a whole.

The Becterew Type. (1893.)—Becterew reported three cases in 1893, and gave a symptom complex which, in his judgment, established a disease entity. This symptom complex was made up of the following features: immobility of the vertebral column, kyphosis, and root symptoms, the latter being evidenced by slight atrophy of muscles, by diminished sensibility in the area supplied by the lower cervical nerves, and by irritation symptoms. Later, he found that a chronic meningeal disease was present, with root compression. He regarded the vertebral column as secondarily affected, the paretic symptoms and muscular atrophy being due, as he believed, to compressed nerve roots.

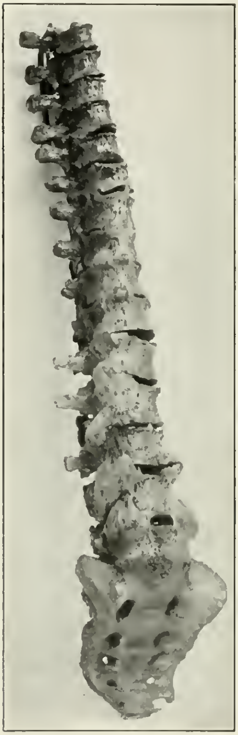

Fig. 330.—Photograph of Spinal Column, showing complete ankylosis extending from the sacrum to the cervical spine. The exostoses, which bridge the intervertebral spaces, are chiefly located on the right side. (Museum specimen in the Medical Department of Washington University, St. Louis, Mo.)

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* Marie, in Revue de Méd., No. 18, 1898, p. 285. † Siven, in Zeitsch. f. klin. Med., No. 49, 1903.

‡ Goldthwaite, in Boston Med. and Surg. Jour., vol. cxlvi., pp. 299–304.

Spondylose Rhizomélique. (Marie, Struempell.*)—The difference between the type described by Becterew and the Struempell-Marie type is quantitative.

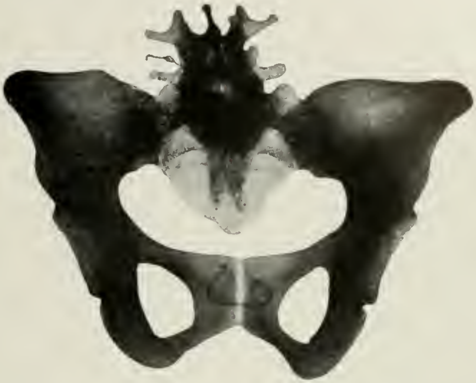

Fig. 331.—Radiogram of Dr. J. Whitridge Williams's Case of Spondylolisthesis. Tube focussed so as to look down into the pelvis (dried specimen). (From Watkins, in *Amer. Jour. Orth. Surg.*, Jan., 1908.)

As pointed out by Liri,† in certain cases of the Becterew type root symptoms were absent. Marie, in a description of this condition, defines it as a complete ossification of ligaments, with ankylosis of the spine as a result. With this process is associated more or less involvement of certain large joints, as the knee joint. Other writers specify the following joints: maxillary joints, knee joints, ankle joints, and small joints. According to Elliott's table the small joints are involved in one-half of the cases. Marie found that root symptoms were very frequently present in these cases, whereas Struempell did not find this to be the fact.

Cyphose Hérédo-Traumatique.—This form was first described by Marie and Astié in 1897.‡ It is an affection similar to spondylose rhizomélique, but it is es-

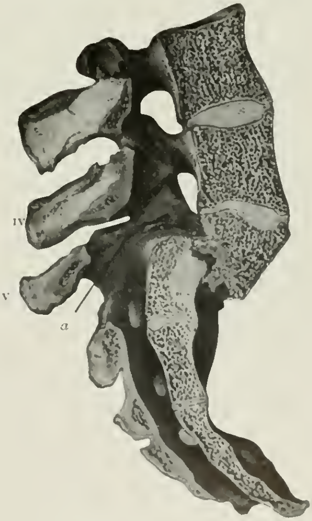

Fig. 332.—Antero-posterior Mesial Section of Spondylolisthetic Pelvis. Dr. J. Whitridge Williams's case. (From Watkins, in *Amer. Jour. Orth. Surg.*, Jan., 1908.) *a*, Line of displacement of the fifth lumbar vertebra. IV, V, spinous processes of the fourth and fifth lumbar vertebræ.

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* Struempell, in Deut. Zeitsch. f. Nervenheilk., 1897, Bd. ii., p. 338.

† Liri, in Soc. Méd. des Hôp. de Paris, 3. Série, No. 16, 1879, p. 237.

‡ Astié in La Presse Méd., Oct. 6th, 1897.

sentially a local affair, not involving the whole spine. It begins with acute symptoms, and soon presents a well-marked kyphos, which is limited in extent and is the seat of bony ankylosis. It is a traumatic affection of the vertebral column, and is similar to the ankylosis following injury to the spine.

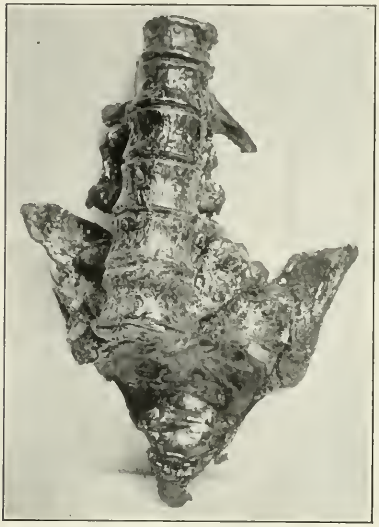

Fig. 333. — Spondylolisthesis. (Museum specimen in the Medical Department of Washington University, St. Louis, Mo.)

For the sake of simplifying the understanding of this class of cases, I have, in the preceding brief résumé, grouped all these affections under one head, realizing that each individually will correspond to a part of the symptomatology presented by chronic ankylosing inflammation. I believe that the difference between these various types is quantitative rather than qualitative, and that all these affections have at their back, as an originating cause, some general disturbance of a trophic nature or some infectious process.

(3) *Muscular Spinal Rigidity.*—One form of spinal rigidity frequently encountered is due primarily to disease of the muscles of the back, which disease at times involves the muscles of the pelvis and thigh. To this affection has been given the name *Rigiditas dorsalis myopatica.* This rigidity gives way under an anæsthetic. It is similar to the condition seen in an attack of what is known as lumbago. The disease becomes chronic, and sometimes, after months of treatment, it disappears, thus making it clear that no bony ankylosis existed.

The cause is unknown, but the disease may perhaps bear some relation to trauma, carrying loads, syphilis, or gonorrhœa.

There are muscle pain and muscle contraction, producing a stiffness and a change in the patient's attitude. At times fibrillary tremor is present. The muscles may be swollen and hard.

Counter-irritation and support constitute the only available treatment.

(4) *Traumatic Spinal Rigidity.*—Direct trauma to the spine often produces a condition similar to chronic ankylosing spinal rigidity. Kuemmell's* disease falls under this head. There is usually a history of severe trauma, followed in from two to eight days by paroxysms of pain in the back, which disappear after a few days' rest. Several months later, severe pain reappears, and a kyphosis develops, which is attributed to a rarefying process confined to the vertebræ.

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* Kuemmell, in Deut. med. Wochensch., Bd. xxi., 1895, No. 11, p. 180.

These cases should either be subjected to immediate surgical treatment, after an exhaustive examination has revealed the traumatic injury to the vertebral bodies, or should be classed with the traumatic spinal neuroses.

Painful Affections of the Spine not Presenting Rigidity.—*The Neurotic Spine.*—This is a condition common in youth and young adult life, and more frequent in females than in males. Injury at times may be cited as a definite cause, though the subjects are usually of a neurasthenic type.

The chief complaint is usually that of a dull pain in the back or neck, and a constant tired feeling. At times the symptoms may be acute and the pains of a neuralgic order. There is a tendency for the spine to bend forward in a curve of weakness. Local tenderness and areas of hyperæsthesia are characteristic of this affection.

As therapeutic measures may be mentioned: the wearing of a back brace or corset, the use of the cautery, and subsequently massage and exercise. Recovery is usually long delayed.

The Hysterical Spine.—This condition is similar to the neurotic spine, the chief difference being one of degree. In the hysterical variety the patient usually assumes positions of lateral distortion, generally in the lumbar region. The appearance of the deformity, the mental condition of the patient, and the history of some severe blow upon the back, will usually make the diagnosis clear.

Spondylolisthesis.—The condition known as spondylolisthesis consists of a displacement downward and forward of one or more bodies of the lumbar vertebræ. Owing to the weakness of the ligamentous support and also to the slanting forward of the upper surface of the first sacral vertebra, it is usually the fifth lumbar which is thus displaced. (Figs. 331, 332, and 333.) Killian first described this condition. It is of especial interest in connection with child-bearing, and the deformity is most frequently seen in women. It is evidenced by symptoms of pain, of limitation in forward bending of the spine, and of weakness; there may also be a swaggering gait such as that seen in congenital dislocation of the hip. Diagnosis is often difficult to establish and it should be borne in mind, as pointed out by Watkins,* that osteo-arthropathies of the spine depending upon tabes often simulate this condition. (Fig. 334.) K. Frank † has collected twenty-seven undoubted cases of tabetic vertebral osteo-arthropathy which

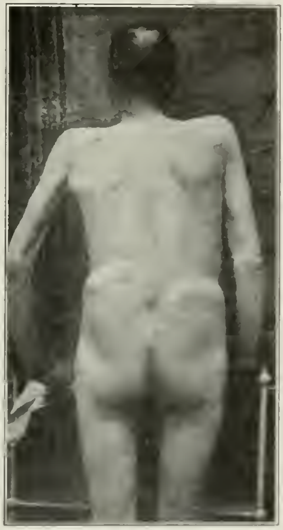

Fig. 334.—Tabetic Vertebral Osteo-arthropathy, Simulating Spondylolisthesis. (From Watkins, in *Amer. Jour. Orth. Surg.*, Jan., 1908.)

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* Watkins, in Amer. Jour. of Orth. Surg., Jan., 1908.

† Frank, K., in Centralbl. f. d. Grenzgebiete d. Med. u. Chir., Bd. vii., Nos. 15, 16, 17, 1904

simulated spondylolisthesis. Treatment of this condition consists in supplying the proper kind of orthopedic appliance, preferably a corset, which will prevent the assumption of distorted attitudes.

IV. CONGENITAL AND ACQUIRED DEFORMITIES OF THE SPINAL COLUMN.

Spina Bifida.—The deformity of the spine known as spina bifida depends for its cause upon certain influences in the development of the spine in fœtal life. It is not possible to state the exact etiological cause of these errors in development. To understand them more clearly, however, it is well to review the development of the spine. The looping up of the two longitudinal folds from the cells of the epiblast so as to form a groove, and the gradual approximation of the ridges so formed, converting this groove into a canal, result in the production of the spinal cord and spinal canal from cells of epiblastic origin. On both sides of this canal, the mesoblast is divided longitudinally in such a manner as to form a thick column—the protovertebral column—which extends from the cephalic to the caudal extremity of the embryo. As development proceeds this protovertebral column undergoes transverse segmentation, being converted into a number of quadrilateral blocks. This process of segmentation commences in the cervical region and progresses to the other extremity of the column, until a number of segments are formed which correspond to the permanent vertebræ. The spinal canal is thus surrounded by a cellular mass which is derived from the mesoblastic layer and which constitutes the membranous matrix of the vertebræ. At intervals along this membranous matrix, the cells become pushed apart by the formation, between them, of a homogeneous substance which later becomes cartilage. The regions which are thus chondrified form the basis for the bodies of future vertebræ, and the spaces where chondrification does not take place form the intervertebral discs. Opposite to each vertebral body further chondrification takes place, producing the cartilaginous vertebral arches. Each vertebra is formed by four primary cartilaginous portions, one for each lamina and its processes, and two for the body. Ossification commences in the laminæ about the sixth week of fœtal life. In

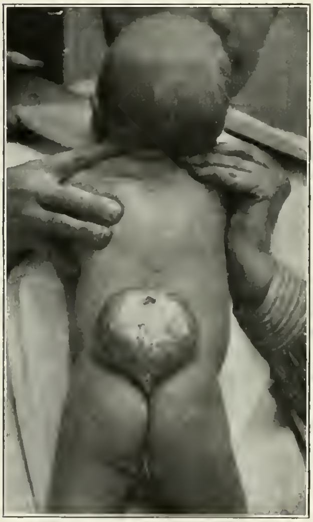

FIG. 335.—Spina Bifida with Paraplegia and Club Feet. The sac protrudes posteriorly, the wall being as thin as paper. This ruptured on the ninth day of life and the child died immediately. Autopsy not obtained. (Author's case.)

the situation where the transverse processes afterward project, the ossific granules shoot backward to the spine, forward to the pedicles, and outward into the transverse and articular processes.

At birth, the three pieces—*i.e.*, the body and the two laminæ—are separate and distinct. During the first year, the laminæ become united behind by a portion of cartilage from which the spinous process is ultimately formed and the vertebral arch made complete. According to some authors, this process of development is carried out more perfectly in the upper spine than in the lower.

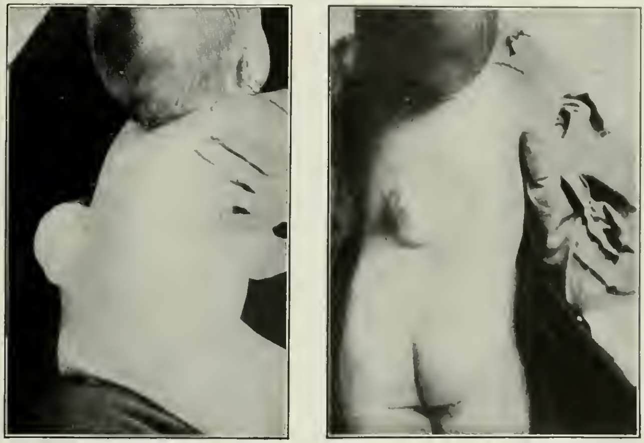

Fig. 336. Fig. 337.

Figs. 336 and 337.—Direct and Profile Views of a Spina Bifida. (From Murphy, in *Neurological Surgery, Surg. Gyn., and Obstetrics*, April, 1907.)

Spina bifida, then, may be defined as a congenital malformation of the vertebral column, depending upon faulty development of the mesoblast, which forms the bones, the meninges, and the muscles. (Figs. 335, 336, and 337.)

There are distinguishable five varieties of this malformation, and these are classified according to the extent of the developmental error. They are:—(1) Myelocele; (2) myelomeningocele; (3) syringomyelocele; (4) meningocele; (5) spina bifida occulta.

The relative frequency with which different localities of the spine are affected is given by Moore* in a report of three hundred and eighty-five cases treated by excision. Of these cases twenty-three per cent were sacral; thirty-four per cent lumbar; twenty-nine per cent lumbo-sacral; 4.5 per cent dorsal; 9.5 per cent cervical; and two cases occipital.

Myelocele.—Myelocele is the most complete form of this malformation; it is incompatible with life for more than a few days. Here the medullary folds have failed to unite, and as a result the central canal of the cord opens upon the surface of the body. This form is usually seen in the lumbar region. Remnants of the cord are evidenced by a velvet-like strand in the median line, of a dark red or reddish-brown color, resembling nævoid tissue. This is composed of the remains of the spinal cord, and consists of nerve cells, neuroglia and nerve-fibres, interspersed with a plexus of vessels. Coexisting with this defect, there will often be found protrusion of viscera and asymmetry of development. Death occurs from the constant leakage of cerebro-spinal fluid.

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* Moore, James E., in Surg., Gyn., and Obst., August, 1905.

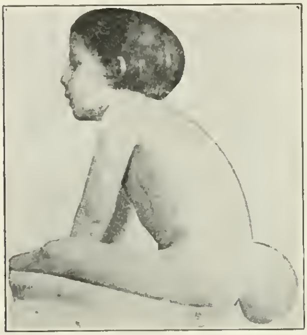

FIG. 338. — Spina Bifida with Paraplegia. (von Bergmann, Bruns, Mikulicz, and Murphy.)

Myelomeningocele. — Myelomeningocele is a deficiency of the vertebral arches which is associated with a tumor varying in size from that of a hazelnut to that of an orange. (Figs. 338, 339, and 340.) It is rounded or of oval shape or may be lobulated by reason of the presence of septa. It is usually situated in the median line, though at times it may be a little to one side or the other. As a rule, it is slightly constricted at its base; in rare instances it is pedunculated. At its summit, where the cord is attached to the wall of the sac, there may be a dimple resembling an umbilicus, or a median longitudinal furrow. The presence or absence of this dimple or furrow depends much on the degree to which the sac is distended by fluid. The sac-wall is composed of epidermis, dura mater, and arachnoid membranes. The sac-cavity is the continuation of the subarachnoid space, and is filled with arachnoid fluid. The skin over this tumor is seldom normal, but normal skin extends up from the base to a variable distance. The rest of the tumor is covered with membranous tissue, which may become ulcerated, or even gangrenous. According to the report of the Clinical Society of London, this is the commonest form of spina bifida, constituting 63.2 per cent of all cases. It may appear in any portion of the spine, but is far more frequent in the lumbo-sacral region. The infant may be in good general condition, and may have its functions intact; on the other hand, there may be paralyses of sphincters and of the muscles of the lower limbs, evidenced by club-feet and trophic changes. A frequent and important complication is hydrocephalus.

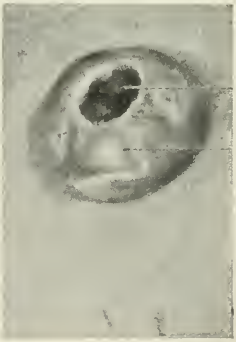

FIG. 339. — Myelomeningocele. (von Bergmann, Bruns, Mikulicz, and Murphy.)

Syringomyelocele.—Syringomyelocele is differentiated from myelomeningocele by the fact that the tumor, although it looks like that seen in the latter condition, contains the spinal cord and its membranes; the cavity of the sac being formed by the distention and protrusion of the central canal of the cord. This is a very rare form and is situated laterally. Like myelocele it is often associated with ectopia vesicæ, genital fissure, and other serious developmental errors.

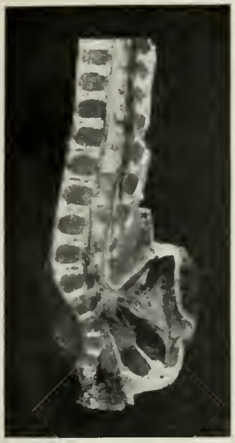

FIG. 340.—Spina Bifida (Myelomeningocele), showing cord and nerves crossing sac. (Guy's Hospital Museum.) (Murphy: "Neurological Surgery," in *Surg., Gyn., and Obst.*, April, 1907.)

Meningocele.—Meningocele is a tumor similar to that known as myelomeningocele; the difference between these two forms being that in meningocele the membranes surrounding the cord alone protrude, while the cord remains in its normal position in the spinal canal. (Figs. 341–346.) The cavity of the tumor is lined by arachnoid membrane. This form of tumor has a tendency toward pedunculation, and only in rare cases has the aperture of communication been occluded. As regards the frequency of meningocele, it occurs in about eight per cent of all cases of spina bifida. It is important to distinguish the condition from myelomeningocele, and, in our endeavors to make the distinction, the following points should be remembered:—There is usually, in myelomeningocele, a deficiency of large size in the arches. Meningocele is never dimpled or furrowed. The presence of paralyses and congenital deformities elsewhere points toward myelomeningocele. The translucency of the tumor cannot be relied upon as a distinguishing feature. Finally, myelomeningocele is most frequently seen in the lower spine.

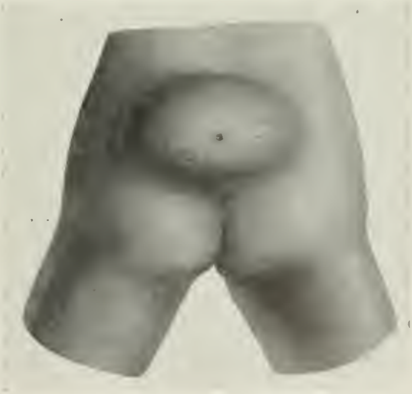

FIG. 341.—Sacrococcygeal Tumor (Teratoma), with an opening which extends entirely through the sacrum, and communicates with the rectum. (From Keen and Coplin, in *Surg., Gyn., and Obst.*, Nov., 1906.)

Spina Bifida Occulta.—Spina bifida occulta is characterized by the presence of a cleft in the vertebral arches without the protrusion of membranes or nervous tissue. Hypertrichosis, when localized over the lower spine, loins, or buttock, is symptomatic of this condition. At times this is the only symptom. The condition, however, may be associated with anæsthetic areas, club-feet, or trophic changes in the lower extremities. At times a defect in the bones may be felt, and again there are heterogeneous growths and cicatricial changes in the overlying skin.

Treatment.—Treatment of spina bifida is of two kinds—operative and non-operative. Non-operative treatment consists in protecting the sac from injury; in dressing antiseptically its surface, if it is ulcerated or gangrenous; and in painting the surface with iodoform or collodion, in cases in which the wall of the sac is thin.

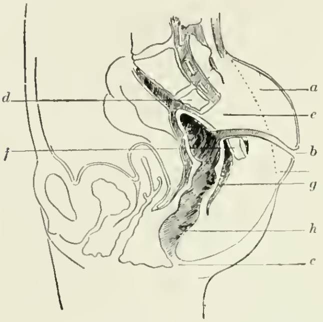

Fig. 342.—Diagrammatic Scheme Intended to Show the Supposed Relations of the Parts in the Case of Sacrococcygeal Tumor Pictured in Fig. 341. *a*, Tumor; *b*, mouth of sinus, communicating with the rectum; *c*, anus; *d*, second sacral vertebra; *e*, defect in sacrum; *f*, end of sacrum; *g*, retrorectal connective tissue; *h*, rectum. (Keen and Coplin.)

Under operative treatment there should be included tapping, injection, and excision. Those cases in which operative treatment is not resorted to are very apt to terminate fatally in consequence of the leakage of cerebro-spinal fluid or of the infection of the meninges. The prognosis, with operation, depends upon the character of the tumor, the age of the patient, and the kind of operation employed. Where the tumor is large-sized and its covering is thin, where the complication of hydrocephalus exists, in all cases of myelocele, and in most cases of myelomeningocele with paralytic complications, the result of operative interference is either death or a failure to effect a cure. In children of a very tender age the operation is accompanied by a high mortality rate and it does not stop the advance of the disease; in those who are five or more years old, operation may, as a rule, be safely done, as few cases that are inoperable reach the age of five years. The object of operation is to relieve the patient of an unsightly and annoying tumor which, owing to the danger of rupture and infection, is a constant menace to his life.

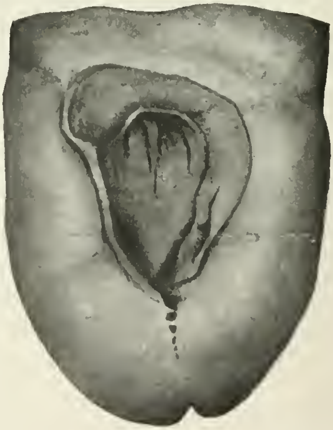

Fig. 343.—Spina Bifida. (Porter, in *Indiana Med. Jour.*, January, 1908.)

Operative Procedures.—The injection of iodine has for its aim the production of adhesive inflammation. It is an operation which should not be employed on children less than two months old, nor where there is hydrocephalus or marasmus. It is accompanied with great danger from shock, convulsions, meningitis, paralysis, and the appearance of hydrocephalus.

Excision.—The age of the patient has much to do with the decision to operate. Statistics show that, when the child has been operated upon within the first few months of life, the result has been fatal in over thirty-five per cent of the cases, while in children five or more years old the operation has resulted fatally in but 1.7 per cent. This difference is due to the fact that children who live to be five years old are good subjects for operation, and the inference seems to be warranted that it is unwise to operate upon these cases too early. Hanssen,* who examined the literature of the subject, found reports of one hundred and fifty cases that had been treated by excision, with a mortality of twenty-seven per cent. Bayer† reported fourteen cases, and concluded that surgical interference is admissible even in cases where the filum terminale of the cord and the surrounding nerve roots are attached to the sac-wall. He later reported three additional cases, and concluded that fifty-nine per cent of all patients operated upon for spina bifida will die, and that the operation should not be performed where there is hydrocephalus, where there is paralysis, and where complications are expected in the sac. Hildebrand‡ has reported thirteen cases, mostly myeloceles and myelomeningoceles; and he expresses the belief that cases complicated by irreparable deformities and severe paralyses should not be operated upon. Sachtleben§ has reported thirty cases, of which number eighteen were operated upon. Six of the latter died and twelve were locally cured. Three and one-half months after operation six of these cured patients died. In the six remaining cases, in which a permanent cure appears to have been secured, the local condition was that of a simple meningocele. Mayo Robson|| has reported twenty operations, with a mortality of thirty per cent.

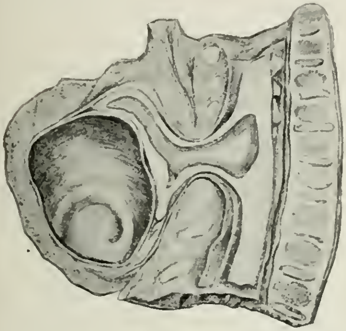

Fig. 344.—Meningocele with Syringo-myelocele; vertical antero-posterior section. (Sutton.)

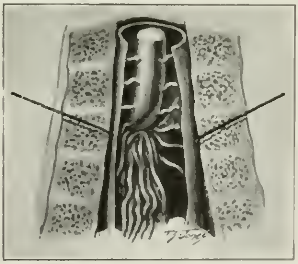

Fig. 345.—Section of a Spina Bifida Showing Nerves Crossing the Sac. (M. B. Clopton's case.)

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* Hanssen, Stockholm, 1895, No. 3, pp. 1–49.

† Bayer, in Prag. med. Woch., 1892, pp. 17–317; and in Zeit. f. Heilk., Berlin, 1897, 18–405.

‡ Hildebrand, in Verhdl. d. D. Ges. f. Chir., 1893, p. 69.

§ Sachtleben: Inaug. Diss., Breslau, 1903; Cent. f. Chir., 1904, p. 341.

|| Robson, in Ann. Surg., 1895, p. 22.

He advises operation in all cases except where one or more of the following conditions are present: a large fissure, marked hydrocephalus, and paralysis. Moore* reports seven cases with one death. His cases, however, were carefully selected. They were cases in which the coverings of the cord were intact and in which there were either no complications or complications of a very mild nature. Furthermore, the children upon whom the operation was performed were old enough and well enough to give promise of future usefulness. Lovett † has reported twenty-four cases, nine of which died within three weeks of the operation—a mortality amounting to 37.5 per cent. This result suggests the idea that the operation itself, in some instances, was the cause of death. Of eleven patients operated upon by him in private practice, only two died, which is perhaps more nearly representative of what the result would be in carefully selected cases. He believes that, in cases which are suitable and which are operated upon by surgeons used to the work, the mortality would be in the neighborhood of twenty-five or less per cent. He states, further, that it seems wiser not to operate in the first two or three weeks of life; but he believes, on the other hand, that there is considerable danger in allowing children to wait for several years, as advocated by many surgeons. He bases this belief upon the fact that so many of these children die in the first year if they are not operated upon at this early period.

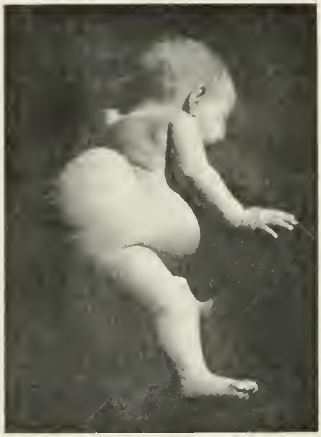
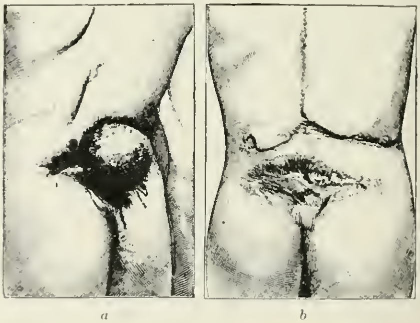


FIG. 346.—Anterior and Posterior Spinal Bifida. (Murphy, in *Annals of Surgery*, 1904, pp. 613.)



a *b*

FIG. 347.—Case of Meningocele. (von Bergmann, Bruns, Mikulicz, and Murphy.) *a*, Condition before operation; *b*, condition twelve weeks after operation.

The points in the operation which seem to be of greatest importance are as follows: After the tumor has been excised, the nervous tissues should be returned as nearly as possible to their places, and the defect in the bone should be well covered. The adoption of absorbable buried sutures and the employment of modern aseptic methods have done much to produce good results in this operation. The implantation of bone from animals, for the purpose of filling the bony defect in the canal, has not been successful. Filling the gap with transplanted bone from the iliac crest, from the remains of the sacral arches, and from the tuberosities of the posterior surface of the sacrum, as recommended by Zeneko,* has been successful, but Bayer believes that muscles and fascia are sufficient. Mikulicz obtained good results with neither muscular nor bony flaps. Moore believes that it is of advantage to have a simple technique. He advocates the plan of operating with the patient placed in the prone position, with hips elevated. The skin flaps should be made so redundant that they can be approximated without tension. The sac should then be freely opened. When the tumor is a simple meningocele, it should be dissected free down to the cleft, and then cut away, only enough tissue being left to make ample meningeal flaps. Where nerve filaments are present they should be dissected free and should then be returned within the cleft. In cases where these filaments cannot be returned, they may be removed without harm. It is probable that much time has been wasted in the effort to preserve functionless nerve filaments. The meningeal openings should be closed with fine chromicized catgut. Flaps of muscle and fascia should then be dissected from both sides of the cleft and brought together without tension.

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* Moore, in Surg., Gyn., Obst., August, 1905.

† Lovett, in Am. Jour. Orth. Surg., October, 1907, p. 208.

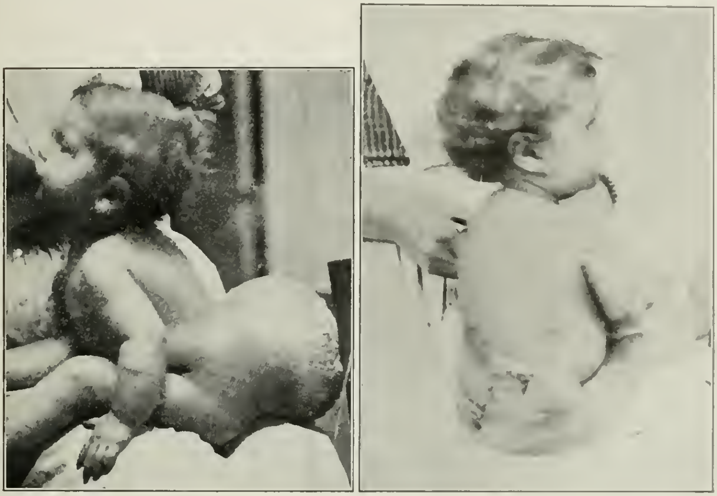

Fig. 348. Fig. 349.

Figs. 348 and 349.—Large Spina Bifida. (Porter, *Indiana Medical Journal*, January, 1908.) Fig. 348 shows the condition before operation, and Fig. 349 that after the operation.

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* Zeneko, St. Petersburg, 1895.

The integumentary flaps should be united with silk. Lovett adds that a tight and efficient closure in the opening of the canal is essential, as continuous leakage of spinal fluid is badly borne in young children. As regards the after-treatment, it is important that the dressing of the wound should be watched very closely and that it should be done as infrequently as possible, although it is rarely safe to leave the dressings in place longer than two days at a time. The nursing of these cases is of the utmost importance, special skill on the part of the nurse in handling infants being very necessary. (Figs. 347, 348, and 349.)

Spina bifida occulta demands no special form of treatment. Its association with spinal malformations, with areas of anæsthesia, with club-foot, and with perforating ulcers and other trophic changes, should be borne in mind. If there is a tumor, it should be treated by excision.

Scoliosis.—Scoliosis, or rotary lateral curvature of the spine, is either an habitual or a fixed deformity, in which the spine as a whole, or in part, deviates to one or the other side of the median line. An important distinction must be recognized as existing between the habitual deformity and the fixed deformity. In the *habitual deformity* the patient assumes an improper attitude, and the accommodative changes in structure have not advanced sufficiently to prevent voluntary or passive correction. In the *fixed deformity*, on the other hand, a structural change has already taken place in the bones and other tissues, as evidenced by the persistence of rotation, after the lateral deviation has been overcome.

Lateral curvature of the spine is a simple deformity; it is not accompanied by any symptoms of active disease. The body is inclined to one or the other side, and there is general loss of symmetry, even in the earlier stages of the affection. If the inclination of the body is toward the left, the right arm will hang in close apposition to its lateral border, while on the left side an interval will appear between the arm and the chest. A curvature in the dorsal region will raise one or the other shoulder, the scapula on the affected side projecting and having the distance between its posterior border and the median line increased. Rotation is shown by projection of one side and corresponding flatness on the other. The presence of a lumbar curve is evidenced by an accentuation of the iliac crest, on the side opposite to that of the curve. Changes appear on the anterior surface of the body, such as apparent loss of symmetry and diminution in the size of the mamma on the side opposite the curve. A general drop of the body and a flattening of the chest are seen as early symptoms of this deformity.

Lateral curvature may be simply one of the so-called static deformities which result directly from the pressure of superincumbent weight, producing first rotation and later lateral deviation of the spine.

Lateral curvature may be secondary, depending upon deformity elsewhere, such as torticollis, either congenital or acquired, strabismus, or the distortion of one or both of the lower extremities (for example, adduction of the thigh). Secondary lateral curvature may result from an attempt on the part of nature to compensate for deformities elsewhere, as where the lower extremities are of unequal length, giving rise to tilting of the pelvis; or it may owe its origin to anterior poliomyelitis, which causes inequality in the length of the limbs, or to unilateral paralysis of the trunk muscles, which causes unsymmetrical expansion of the thorax and so leads to lateral curvature. Disease within the thoracic walls may also cause secondary lateral curvature, as in the case of persistent empyema. In this condition the lung is primarily compressed by the effused fluid, and its function is abolished by the adhesions which form within the thoracic cavity. Thus the affected side of the chest becomes collapsed, and the unaffected lung is called upon to do double duty, which results in expansion of the corresponding side of the chest and, secondarily, in extreme lateral curvature of the spine, with its convexity toward the active side. Other conditions inside the thorax, produced by disease of the lungs, may result in secondary lateral curvature. Direct injury, as fracture of the spine, may induce secondary lateral curvature. Pott's disease and sacro-iliac disease, with their resulting distortions, may induce slight permanent lateral curvature. Secondary lateral curvature may result from occupations that require habitual inclination of the body, as does the work of stone-cutting. It has been often observed that lateral curvature is produced, in rapidly growing children who are affected with rickets, by the manner of sitting which the child assumes, or by the manner in which it is supported on the mother's arm. Finally, it may result from the tilting of the pelvis due to unilateral knock-knee or to some other rhachitic distortion that causes inequality of the lower extremities.

Pathology.*—Scoliosis is a deformity, not a disease; except when secondarily produced, it is not the result of disease. It may be characterized as a general distortion of the spine, in which the column as a whole is bent and twisted and in which each component segment bears its share of the distortion. The individual vertebræ, at the apex of each curve, show the greatest change. Where the rotation and lateral deviation are to the right, the vertebral body is somewhat wedge-shaped, the apex of the wedge being directed backward and to the left. The lateral diameter of the body is increased, and the superior and inferior margins at the narrow side project. This distortion is accompanied by similar changes in the articular processes and laminæ. On the concave side all parts are broadened, shortened, and lessened in vertical diameter. The neural canal becomes ovoid in outline, the base being directed toward the convexity of the curve. The vertebræ included in the compensatory curvatures show reverse deformities, and the intermediate segments show transitional changes between the two extremes. The discs between the vertebræ become wedge-shaped and atrophied on the shortened side. Section of these deformed vertebræ reveals an internal structure in which adaptive changes are evident,—changes which consist, in the narrowed parts of the bone, of an increase in compactness, while on the opposite side they represent rarefaction and atrophy.

These bone changes lessen the mobility of the spine to such an extent that, at the points of greatest distortion, there is practically a state of ankylosis. The muscles of the back undergo adaptive changes, and become relatively weak. Distortion of the trunk results, and this distortion is especially evident in the changed shape of the thorax. As stated by Whitman, this may be understood better by regarding the sternum as a fixed point. At the apex of the convexity of the curve, the ribs are drawn sharply backward; their angles project by the side of and beyond the spinous processes, sometimes covering and concealing them, and the lateral convexity of the chest on that side is diminished or lost. On the opposite side, the back is broadened and flattened. The effect of the rotation is to diminish the capacity of the chest on the convex side, and to increase it on the concave side. The ribs on the convex side are elevated, and their inclination is increased. On the concave side, the intercostal spaces are narrowed, and the inclination is lessened. The antero-posterior diameter of the chest is increased or diminished according to the change in the antero-posterior contour of the spine. (Figs. 350 and 351.)

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* The data on which a large part of this and the succeeding sections is based are contained in the following articles:—R. W. Lovett: Boston Med. and Surg. Journal, June 14th, 1900; Oct. 31st, 1901; March 17th, 1904; Sept. 28th, 1905; also Am. Jour. of Anatomy, vol. ii., No. 4, p. 457.—Schulthess, Schanz, and Lovett: Verhandl. d. Deutsch. Gesellsch. f. orth. Chir., vol. iv.

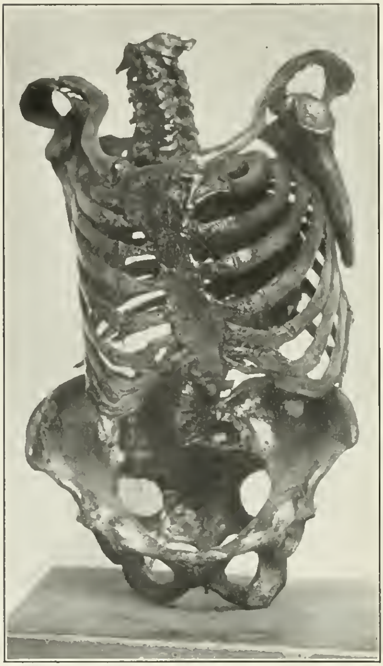

FIG. 350. Extreme Lateral Deviation of the Spine with Secondary Deformities of Ribs and Sternum; front view. (Museum specimen of the Medical Department of Washington University, St. Louis, Mo.)

The skull may show accommodative changes similar to those seen in persistent torticollis, where, owing to the pronounced character of the curve, the head and neck are habitually distorted in their relation to the spine.

The pelvis, as a rule, does not show important changes. In some instances, the oblique diameter may be increased, and, if the lateral deviation of the lumbar spine is extreme, the pelvis may be so tilted that the limb on the elevated side becomes practically shorter than its fellow.

As to the secondary changes which are brought about in the viscera by these distortions, lack of space will not permit us to say very much. The thoracic movements are diminished, and at times suppressed, so that it is necessary for respiration to be almost entirely diaphragmatic. One or the other lung becomes compressed and atelectatic, its fellow showing compensatory emphysema. In ninety per cent of cases, the heart is enlarged, with or without dilatation of its cavity. The aorta, fixed to the spine by intercostals and fibrous tissue, bends with the spine and curves its branches to such a degree as to obstruct their lumen, thus inducing hypertrophy of the left ventricle. The liver is forced to develop in a vertical rather than a transverse direction. Of less importance are the changes which take place in the kidneys, the stomach, and the intestinal tract.

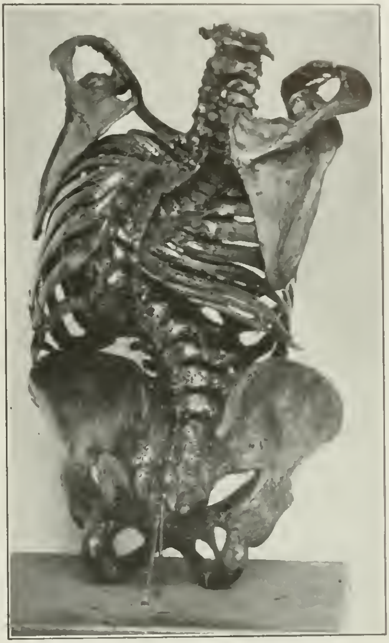

FIG. 351. Rear View of the Specimen Shown in Fig. 350.

ETIOLOGY.—Lateral curvature of the spine is generally stated to be the most common of deformities. Whitman reports that, in a period of fifteen years, 3,252 cases of this nature were treated at the Hospital for Ruptured and Crippled, in New York. Drachmann found, among 28,175 school children in Denmark, 368 cases of scoliosis (1.3 per cent). Scholder, Werth, and Combe found 571 cases among 2,314 school children in Switzerland (24.6 per cent). Lateral curvature of the spine is far more common among females than among males. Of Whitman's 3,252 cases, 698 were in males and 2,554 in females, making the relative percentages 21.5 per cent and 78.5 per cent. Other observers have reported smaller groups of cases, in which the disproportion between females and males is somewhat less. Whitman is of the opinion that this unequal distribution of the deformity between the sexes is less marked in early childhood, and that this may be accounted for to some extent by the differences in dress and in the manner of life. Of his 3,252 patients, 1,299, or 39.9 per cent, were less than 14 years of age: 1,576, or 48.4 per cent were between 14 and 21; and 377, or 11.6 per cent, were more than 21 years of age. These statistics show simply the ages of the patients at the time when treatment was sought. Truslow cites 181 patients, of which number but 14 were more than 13 years of age at the time when deformity was first noticed, although nearly fifty per cent were older than this when treatment was applied for.

As etiological factors in the causation of lateral curvature, the following conditions must be taken into consideration: the erect posture of the body and the force of gravity; and the tendency produced by gravity to sinking forward and to increasing the posterior curvature of the spine. Couple these conditions with general weakness from any cause, with overwork that may induce fatigue and may add to the difficulty of holding the trunk erect under the pressure of its superincumbent weight, and we have a combination of static and physical conditions which would predispose to the development of such a curvature of the spine. Predisposing causes are hard to discover.

The causes of lateral curvature may be divided into two classes:

(1) Predisposing causes, such as general debility, laxity of ligaments, constitutional diseases,—as, for example, rickets,—variations in the anatomical structure of the vertebræ, and prenatal influences.

(2) Proximate causes, such as those which are of a local character and which disturb the equilibrium. Among these are faulty attitudes in either the sitting or the standing posture, long-continued irregular distribution of body weight in certain occupations, acquired deformities (such as those which occasion inequality in the lengths of limbs), and visual defects.

Boehm,* in a recent article on "The Cause of Habitual Lateral Curvature," shows that the developmental error of the human body which occurs in embryonic life, and has its morphological expression in the so-called "numerical variation" of the spine, may, under certain circumstances, cause those idiopathic lateral deformities of the spine which manifest themselves in the first half of the second decade of life, and which have heretofore been considered affections due to functional, or functional-osteopathic, conditions. In sixteen out of twenty cases of so-called habitual scoliosis, he found pathological types of variation at the primary seat of deformity. Truslow found that about fifteen per cent of the cases of scoliosis presented one or more causes that favored the production of lateral deviation of the spine; these causes partaking of the nature of deformities. In eighty-five per cent of the cases, no direct cause could be ascertained. (Figs. 352 and 353.)

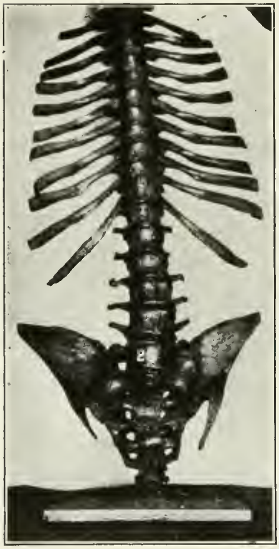

FIG. 352. — Lumbo-sacral (Caudal) Variation and Lumbo-sacral Scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine," in *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)

It has been pointed out by many writers that hereditary influence plays an important part in the etiology of scoliosis. In the ordinary case, however, it is difficult to establish the influence of heredity. Out of 201 patients questioned with this point in view, Whitman† found only 11 who gave a history of having either the father or the mother so affected. In 17 other instances it was ascertained that a brother or a sister of the patient was deformed in a similar manner. Occupation and habit of posture are well-recognized factors in the production of deformity. The occupation of childhood is normally that of attendance at school. It has been pointed out by numerous observers that a high percentage of school children present lateral curvature of the spine. Lovett, in a recent article, says that twenty-six per cent of the school children have lateral curvature of the spine. The persistent maintenance of an improper attitude by children when sitting during school hours, and especially when writing, has been demonstrated by Kocher, Staffel, and Lorenz. The faulty position is caused somewhat by the method of holding the writing paper. Gould has recently shown the importance of visual defects in the production of this faulty attitude in school children. All children who assume these faulty attitudes do not necessarily become scoliotic. The longer a child is obliged to sit and write, the quicker the faulty position will develop. This is assumed as an explanation of the greater frequency of scoliosis among girls who, in the method of their education, are obliged to do needlework and take piano lessons after the long hours of school, whereas boys, after school hours, engage in games which are inclined to strengthen their muscles and offset the vicious influence of the long hours of sitting in the schoolroom.

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* Boehm, in Bost. Med. and Surg. Jour., Nov. 22d, 1906.

† Whitman: "Orthopedic Surgery," N. Y., 1907.

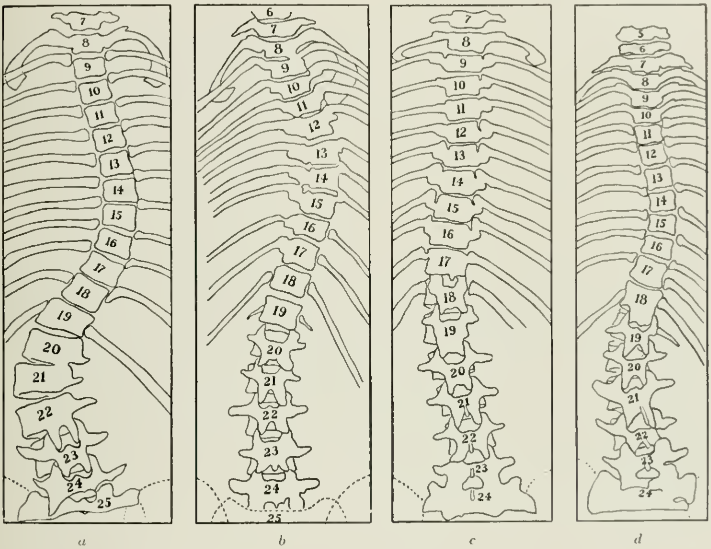

FIG. 353. Variations in the Curve of the Spine in Scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine," in *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)
a, Variation in a caudal direction; *b*, *c*, *d*, variations in a cranial direction.

Clinical Aspects of Scoliosis.—The curvature may be mainly unilateral or C-shaped, and may be in the lumbar or in the dorsal region, or in both. A single curve of large extent is always of serious import, because of the number of vertebræ implicated. When the chief curve is long, the resulting distortion of the body is very considerable; as Fisher states, "the vertebral column, like the keel of a ship, is the foundation of the structure of the trunk." According to statistics from various sources, about three-fourths of all well-developed double curves of the spine are convex to the right in the dorsal and convex to the left in the lumbar region, and are classified as "right" or "left," according to the distortion of the dorsal region, which is the more noticeable of the two. The dorsal curve may be either primary or secondary. Schulthess has tabulated 890 cases of lateral curvature, with the results given below. In 144 cases examined by Truslow, rotation was more marked than lateral deviation in 30 cases, and lateral deviation more marked than rotation in 143. In a series of 201 cases, he found that lateral deviation was single in 39 cases, double in 117 cases, and triple in 24 cases. Whitman states that, of 293 cases, of which a very large proportion were seen in the early stage of the deformity, eighty per cent had inclinations to the left, and that seventy-three per cent of the more fully developed cases were of the right dorsal, left lumbar type.

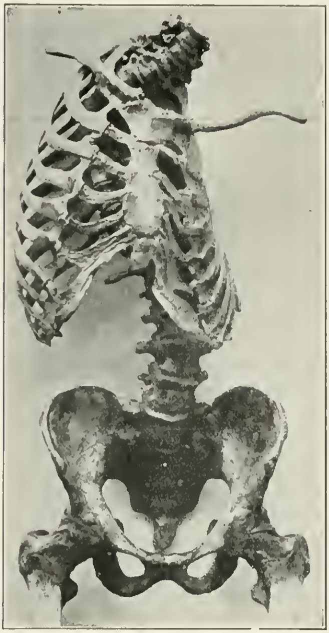

Fig. 354.—Specimen Obtained from a Case of Empyema Scoliosis; it shows complete collapse of the left chest. (After Breuss and Kolisco, in Joachimsthal's "Handbuch," Jena, 1905–1907.)

Cases Examined by Schulthess.

	Left.	*Right.*	*Total.*
Total scoliosis (single curve affecting the entire spine)	173	23	196
Lumbar scoliosis (single curve limited to lumbar region)	63	34	97
Lumbo-dorsal scoliosis (single curve limited to lumbo-dorsal region)	184	164	348
Complicated scoliosis:			
(*a*) right dorsal, left lumbar			
(*b*) left dorsal, right lumbar	58	191	249
	478	412	890

Symptoms.—The first symptom, in the large majority of cases, is the presence of spinal deformity. Pain, however, may precede the deformity; in about one-quarter of Truslow's cases, it was present to a greater or less degree. He found that the pain might be simply the discomfort occasioned by fatigue and by a dragging sensation referred to the lumbar region, or that it might be severe and of neuralgic type. In cases where the deformity is extreme, where the ribs come in contact with the iliac crest, direct pressure may cause severe pain. Deformities of this static nature, depending as they do on general weakness, tend, by hampering normal development and function, to produce a vicious circle. Frequently there are general symptoms of a neurasthenic or hysterical nature, which depend in part upon the deformity, and in part on the general debility. Truslow states that in a large proportion of the cases examined by him, the patients were reported to have been distinctly less active than their companions, not enjoying exercise and inclining to sedentary lives, before the appearance of deformity. Teschner states that these individuals are often indifferent, apathetic, and lazy, and that they often show a lack of co-ordination and muscular control, as an accompaniment to deformity. The period of rapid growth and instability, which appears at adolescence, is apt to be the time for any latent deformity or weakness to become exaggerated. In cases where there is extreme deformity, symptoms due to interference with the respiratory and circulatory apparatus, or to displacements of abdominal organs, may be present.

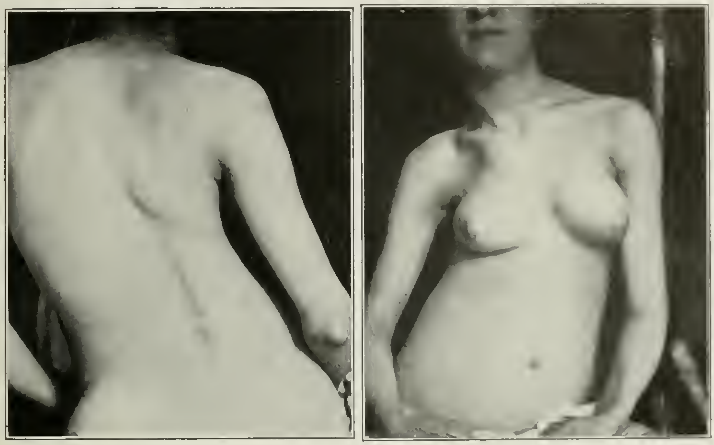

Fig. 355. Fig. 356.

Figs. 355 and 356. Rear and Front Views of a Patient Affected with Extreme Lateral Deviation of the Spine due to Empyema. (From Allison.)

Diagnosis.—If the distortion be at all marked, the diagnosis is easy, the only possible source of error being the lateral deviations met with in rapidly progressing vertebral disease. In the early stages, some difficulty may arise. The onset is often so gradual that care is required not to overlook the signs which, though slight, are of such a nature that it will be impossible for "the child to outgrow them." Any slight alteration in the outlines of the flanks, any flattening or prominence of the erector spinæ, should be regarded as a distinctive sign, as should also slight prominence of one hip or scapula, with elevation of one shoulder. If these departures from the normal are present when the patient is standing in a position naturally assumed, and if they are aggravated when he stoops forward, it may be said that scoliosis is present. (Figs. 357, 358, 359, and 360.)

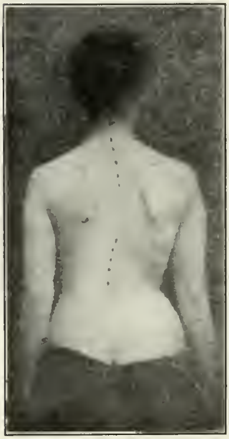

FIG. 357.—Combined S-scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine, in *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)

Simple lateral deviations must not be confounded with scoliosis. They will disappear when the spine is flexed, when the horizontal position is assumed, and when a voluntary muscular effort is made.

Several stages are recognizable:—

First Stage.—In this stage, which is simply that of vicious position, the symptoms are slight, there is little or no curve, and the deformity disappears entirely when the patient is suspended or lies down, or when slight pressure is made upon the prominence with the hand.

Second Stage. — The deformity is already accentuated; the torsion is evident, and the curvatures of compensation have made their appearance. The spine, however, still possesses some flexibility, and suspension or decubitus will produce a varying amount of recession of the deformity.

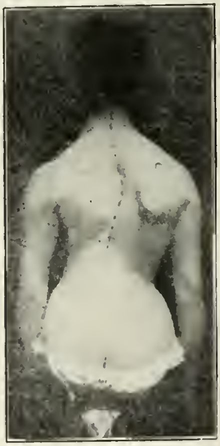

FIG. 358. — Cervico-dorsal Scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine," *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)

Third Stage.—In this stage the curvature is very pronounced. The displacement of the trunk from the vertical line is marked. Deformities of the chest and displacement of the viscera coexist. The spine is rigid and ankylosed, and suspension does not modify the curve. There is marked obliquity of the transverse axis of the pelvis.

Bradford and Lovett * suggest a good means of determining direct lateral flexibility; it consists in placing blocks of wood, or books, under one foot, until the limit of lateral flexion is reached, as shown by the inability of the patient to hold the elevated limb in the extended position. This experiment is then repeated on the opposite side. The range of motion at the shoulder joints is usually restricted, and is almost always accompanied by round shoulders.

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* Bradford and Lovett: "Orthopedic Surgery." N. Y., 1905.

It should be borne in mind that certain diseases of the vertebræ produce scoliosis, and especially that Pott's disease has for an early sign, in some instances, the development of a lateral deviation, preceding kyphotic deformity.

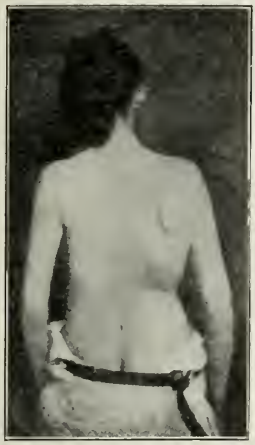

FIG. 359. — Lumbo-sacral Scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine," *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)

In order to establish a diagnosis of scoliosis, the question of the origin of the spinal deviation will have to be well considered. The lower extremities should be measured and examined. The presence of paralysis should be determined. The question of numerical variation in the vertebræ may be determined by skiagraphy. Little difficulty will be experienced in discovering antecedent empyema as a cause, as here the affected chest will show permanent signs of the preceding disease.

It is of the utmost importance, in its relation to the subsequent treatment, to determine whether the scoliosis be secondary to other deformities, or whether it be of the type which is known as rotary lateral curvature. It is important, furthermore, to determine the exact stage to which the deformity has advanced, in order that the proper measures may be instituted for its correction.

PROGNOSIS. — Bradford and Lovett remark: "Two errors in prognosis are common. First, that the disease is of the most serious nature; second, that it is a trivial affection, and will be outgrown by the patient." Each of these statements contains sufficient truth to render it misleading. Lateral curvature may be said to have a preliminary stage, or a stage in which predisposing factors are active. Following this stage, comes a period of progression of deformity, and this, again, is followed by a stage of arrest of deformity. The period of growth has much to do with this progress. If the deformity be in its preliminary stage when the individual is at an early age, the prognosis is more serious than when it makes its appearance during adolescence. Again, a single curve in the spine is more easily corrected than a double or triple curve, provided it is not fixed.

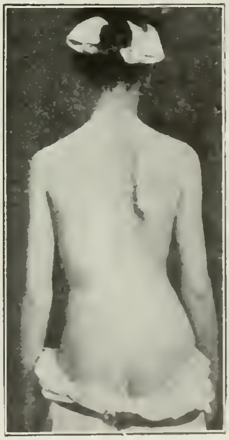

FIG. 360. — Lumbo-dorsal Scoliosis. (From Max Boehm: "The Cause of So-called Habitual Curvature of the Spine," *Boston Med. and Surg. Jour.*, Nov. 22d, 1906.)

If the deformity results from a cause which tends to produce unequal development, — as, for example, empyema, where the lung is irreparably damaged, — the tendency to extreme deformity is irresistible, provided the patient is a child. In adult life such a condition may not result in appreciable distortion. When the cause of the lateral deviation is paralysis of the muscles which hold the spine erect, the prognosis of severe deformity is evident. In the ordinary type of lateral curvature, such as is seen in an adolescent girl, the prognosis must depend largely upon the general condition of the patient and upon the willingness and ability of her parents to institute the proper means in the way of treatment. If she be an individual who is dependent upon an occupation for her living, the character of the occupation is of serious moment. If, at the time when she is brought for treatment, it is discovered that the deformity is fixed, that rotation of the spine has already taken place, it will be difficult, or perhaps impossible, to correct the condition, even under the most favorable circumstances. In such a case, the arrest of further increase in the deformity and the relief of symptoms constitute all that can be obtained, in most instances, in the way of a cure. Such an individual, as she approaches the period of maturity, and as the tendency to further deformity is lost, will develop a symmetrically divided spine and an increased amount of adipose tissue, which will serve to conceal the irregularities incident to her spinal distortion. The deformity, however, may increase in adult life, and even in old age, and produce symptoms of discomfort and actual pain.

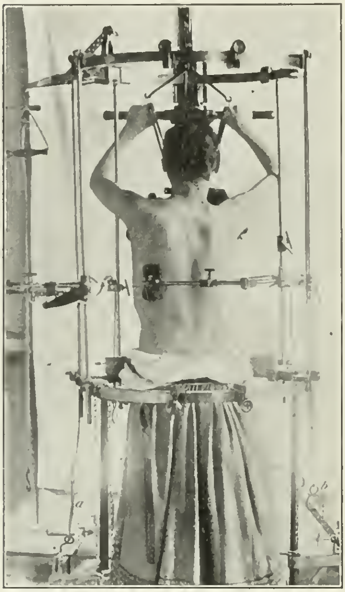

Fig. 361.—Forcible Correction Apparatus for Fixed Spinal Curves. (From Wilhelm Schulthess, in Joachimsthal's "Handbuch," Jena, 1905–1907.)

The site of the curvature influences the outcome. Lumbar curves are less favorable for treatment than are dorso-lumbar or dorsal curves. Curvatures high up are particularly troublesome, as they are beyond the reach of any efficient pressure exerted by apparatus. Primary curvature to the left, in the dorsal region, is more lasting and more liable to increase than are right-sided curves, unless the patient habitually uses the left hand.

In general, it may be said that lateral curvature of the spine is a condition of sufficient gravity to need treatment and watching until arrest of the process is assured. It is far more serious in a young child than in an older subject. The presence of extreme deformity produces weakness, discomfort, and pain. Early deformities may be corrected, and more advanced deformities are not entirely beyond the reach of correction. An absolute cure implies not only an early diagnosis and the early institution of proper treatment, but, in addition, continuous vigilance and exertion.

Treatment.—Scoliosis is a deformity of such complex origin and far-reaching results that no one line of treatment is applicable to all varieties. Each case must be judged on its own merits, and the factors at work recognized before attempts at alleviation are made. The treatment in general may be divided into two classes: (1) the treatment of scoliosis that is secondary to deformity elsewhere (as, for instance, inequality of length of limbs). Here the mechanical necessities for correction are quite evident, and are usually simple in application and efficacious in producing the desired result. (2) Scoliosis that is due to empyema calls for treatment which needs to be described more in detail. These scolioses are of the most extreme type, and treatment, when the condition is recognized at the outset, is difficult for the following reasons. In the first place, the affected lung and pleural cavity are, as a rule, capable only to a very slight degree of performing their proper functions. In consequence, the work of breathing is thrown entirely on the unaffected side. This causes dilatation of the chest and lung, and tends to the production of increased spinal curvature. Appliances or apparatus fitted to the trunk, to prevent distortion, will limit the necessary respiratory movements of the already overburdened chest, and exercises designed to strengthen or increase the flexibility of the spine also demand increased respiratory effort, and are followed by compensatory enlargement of the chest and increase of spinal deformity. It is well, therefore, in the treatment of empyema to remember the possibility of scoliosis as a sequel, and to employ, when there is delayed expansion of the lungs, such methods as the creation of negative pressure by vacuum bottles and the strengthening of the respiratory muscles by suitable exercises.

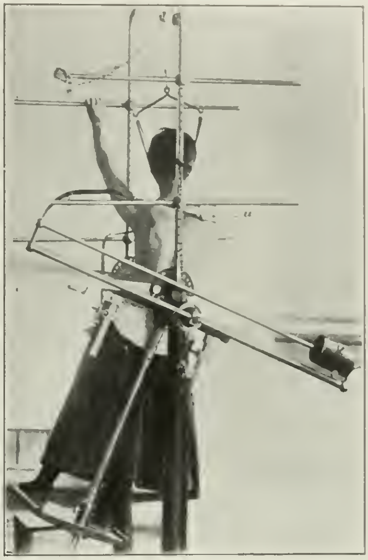

Fig. 362.—Exercising Apparatus for Scoliosis Designed by Wilhelm Schulthess. (Joachimsthal's "Handbuch," Jena, 1905–1907.)

The scoliosis that follows poliomyelitis anterior, where the muscles on one side of the spine are paralyzed, can be treated only by the employment of appliances which will hold the spine erect.

Scoliosis, or true lateral curvature, presents one of the most difficult therapeutic problems which is encountered in surgery. When it is considered, however, as stated by Lovett, that twenty-five per cent of the school children are affected with this deformity, the treatment should not be relegated to traditional exercises and irrational gymnastics, carried on by persons who have but an imperfect knowledge of the subject.

There are two distinct types of scoliosis: the postural or functional type, and the structural or organic type. (1) The postural type is a faulty attitude, or a functional malposition, and is characterized by a single curve of the spine of slight degree—most frequently a left total curve. In this class of cases the malposition may be corrected by restoring to the spinal column its normal flexibility. This is best done by exercises consisting of bending to one side, hanging, circumduction of the trunk, and similar simple procedures which render the spinal column flexible in all directions. The "setting-up drill" of the recruits in the United States Army is an excellent system of exercises for this class of cases. (2) The structural or organic type of scoliosis presents a much more serious and much less encouraging therapeutic problem than does the postural type. Here we have to deal with a lateral deviation of the spine which is accompanied by rotation of the vertebræ. The spine is stiff in the curved portions, and the vertebræ are to a certain extent distorted. The treatment has to be continued for a long time, and willingness on the part of the parents of the patient, and of the patient herself, to comply with the arduous task of effecting such organic changes, is absolutely necessary. The treatment falls under two heads: Measures that have for their object the loosening of the spine, and measures intended to secure for it an improved position.

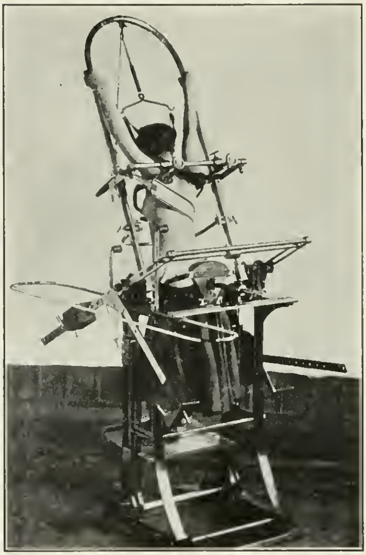
FIG. 363.—Exercising Apparatus for Scoliosis Designed by Wilhelm Schulthess. (Joachimsthal's "Handbuch," Jena, 1905–1907.)

(*a*) *Measures that have for their Object the Loosening of the Spine.*—To obtain greater mobility of the vertebral column, free standing gymnastics, such as side bendings of the spine and such other exercises as are simple and corrective, should be employed. Gymnastics given on apparatus, such as those used in Germany, are well suited to all cases except the most pronounced, and, when used for a proper period of time, they are capable of producing most excellent results. The aim which is constantly kept in view in these apparatus is to increase the flexibility of the spine and to strengthen the muscles of the back.

Passive stretching of the spine, with a view to restoring mobility and making an improved position possible, is secured by hanging by the arms and by traction on the head by means of the Sayre sling.

In the more aggravated cases of structural lateral curvature forcible correction is efficient and is best applied in the manner advised by Lovett. He places the patient in the prone position,—in which position the spine is in the most favorable condition for side correction, as regards both deviation and rotation,—and by an intelligent application of force he corrects both of these faulty elements at different levels. Then, after this has been accomplished, he applies a plaster-of-Paris jacket. Such a jacket is applied with the hope of stretching the contracted structure and inducing an improvement in the curve; and one of the great advantages which it possesses is, that it keeps the force constantly applied. (Figs. 364 and 365.)

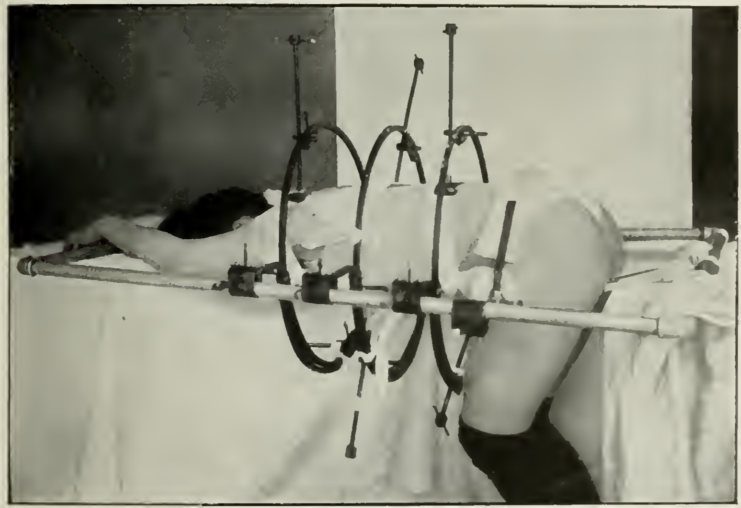

Fig. 364.—Apparatus for Facilitating the Application of a Plaster Jacket. (From Bradford and Lovett: "Orthopedic Surgery.")

(*b*) *Measures intended to Secure for the Spine an Improved Position.*—The intelligent use of gymnastics is of the greatest importance in rendering permanent the improvement in position which has been secured by forcible correction or by correction through the use of gymnastics. These gymnastics, which should be modified according to the characteristics of each individual case, consist of backward bendings and symmetrical heavy gymnastics, as well as of self-correcting exercises. In the latter class, the patient lifts herself into a corrected position and then maintains it as long as possible. There is also the so-called "Hoffa self-correction," in which the patient with a right dorsal curve places the right hand on the thorax and the left hand on the left hip, and by a side pressure presses the right side of the thorax toward the left.

Retention by apparatus is desirable, in order that a corrected position may not be lost until the muscles shall have acquired such strength that the apparatus may be dispensed with. Pronounced lateral curvature should not be treated with corrective apparatus. The most easily made apparatus is the corset, which is constructed by removing from the patient a correcting plaster-of-Paris jacket and then filling this with plaster of Paris. A model of the patient's trunk will thus be secured. This may be further corrected by cutting away the plaster on the convex side, and building up the concave side, so as to secure a symmetrical or over-corrected model. On this model, a jacket of celluloid, leather, or other material, or corsets made of cloth and reinforced by steel, can readily be made. Any brace which will maintain the trunk in a corrected position may be said to be satisfactory.

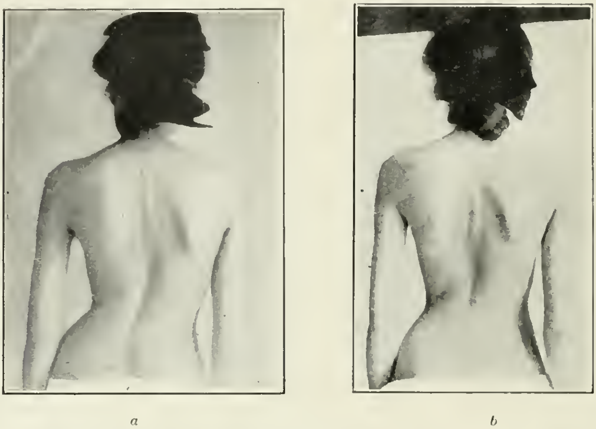

FIG. 365. Lateral Curvature of the Spine. (From Lovett.) *a*, Before application of a corrective plaster jacket; *b*, after treatment during a period of two months.

A daily routine should be insisted upon, in order to obtain a good condition of general health. The patient should follow her exercises with periods of rest in recumbency, and should be encouraged to undertake methods of distending the chest, as by singing. The treatment of lateral curvature involves many special points, on which there is a profuse technical literature.

Scoliosis of Congenital Origin.—The scoliosis which is due to congenital errors in the formation of the spine has, since the development of the *x*-ray for surgical purposes, been found to be much more frequent than was formerly supposed. The importance of the rôle played by malformation of the vertebral column in the production of scoliosis has been emphasized by many observers during the last decade. Boehm* has laid special stress on the fact that many cases of scoliosis are of congenital origin, the curvature not appearing until development has made considerable advance. He bases his conclusions upon the frequency of numerical variation in the vertebræ. Bardeen† estimates that this variation occurs in from fifteen to sixteen per cent of all spines and Boehm has found, by radiographic examination of twenty-four cases of habitual scoliosis, that sixteen presented types of variation in the vertebræ at the primary seat of deformity. These variations in the development of the spinal column may be clinically divided into the following groups: one in which cervical ribs are present, a second in which there are lumbar ribs, a third in which there are extra lumbar vertebræ, a fourth in which there are sacralized vertebræ, and a fifth in which certain vertebræ are lacking. (Lovett.‡) Variations are found more frequently at the posterior end of the spinal column. (Figs. 366 and 367.) As to the cause, Dwight § makes the following statement:—"The cause of the original error is yet undetermined, but there is no reason to suppose that it is a step toward the future or the result of heredity." Colville‖ examined ten hundred and fifteen new-born children for the purpose of ascertaining the frequency of scoliosis, and he found it in but one child. Cases, however, have been reported in which the curve was evident at birth, and in these instances the scoliosis was usually

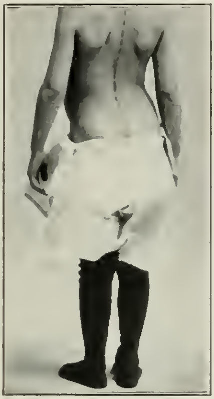

Fig. 366.

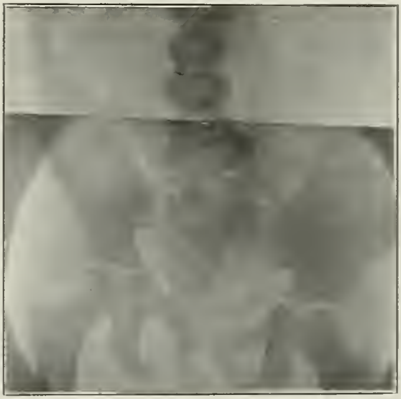

Fig. 367.

Fig. 366.—Congenital Scoliosis, with long dorsal curve to the left. (Allison.)

Fig. 367. Skiagram of Case Shown in Fig. 364, showing numerical variation of last lumbar and first sacral vertebræ, with deficiency of sacro-iliac joint. (Allison.)

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* Boehm, in Boston Med. and Surg. Jour., Nov. 22 l, 1906.

† Bardeen: "Numerical Vertebral Variation in the Human Adult and Embryo." Anat. Anz., Bd. 25, Jena, 1904.

‡ Lovett. "Lateral Curvature of Spine and Round Shoulders." 1907

§ Dwight, in Anat. Anz., Bd. 15, 1901.

‖ Colville, in Rev. d'Orth., 1896–97.

associated with some spinal abnormality such as spina bifida or spina bifida occulta.

Where the scoliosis is due to a congenital defect of the vertebræ, or to a variation of the scapulæ, or to a malformation of the thorax, the prognosis, as regards a cure, is bad; but it may be stated that proper appliances, exercises, and careful watching will do much to prevent these curves from increasing as development progresses, and will also preserve the flexibility of the spinal column.

V. TUMORS OF THE SPINE AND OF THE SPINAL MARROW AND ITS MEMBRANES.

INTRODUCTORY REMARKS.—Before the publication of the paper by Gowers and Horsley, in 1888, spinal tumors were considered beyond surgical reach. The publication of this paper, however, gave an impetus to the study of this field of surgery, and as a result the character of these tumors and the manner in which they may be treated by surgical means are now much better understood. Although Gowers and Horsley are generally credited with having done the first operation for the relief of a new-growth of the spine, it is to a French surgeon, Bazy, that the honor is really due, notwithstanding the fact that he did not report his case until several years after the two distinguished English surgeons had published an account of theirs.

Through the labors of many surgeons and neurologists during the last two decades, the knowledge of these conditions of the spine has been brought to a point where it is possible to recognize them clinically, to locate definitely the level of the spine involved, and to employ surgery as a means for their relief. In order that these cases may be properly understood from a clinical standpoint, —*i.e.*, in order that the portion of the cord impinged upon or destroyed may be located,—a thorough knowledge of the topographical anatomy of the spinal cord, with special reference to each segment and its peripheral distribution, is necessary. In a topographical way the spinal cord presents merely the problem of what is called level diagnosis. A short study of the table of cord levels in any textbook will show, within two or three spinal segments, just where a lesion probably is. (See Vol. I., page 543 *et seq.*) The diagnosis of the lesion itself, whether it is located in the cord or not, is a much more difficult problem. Cushing (*Johns Hopkins Bulletin*) thinks that there are no clinical puzzles more interesting to disentangle, none more confusing when left in a snarl, than those connected with the segmental localization of cord lesions—the determination, from the disturbances of function, as to the transverse extent of the lesion; a decision as to the recoverability of the injured tract; and a knowledge of just where the intact arches of the spinal vertebræ must be entered in order to expose the focus of disease.

A study of the literature of this subject, which is voluminous, impresses one with the fact that many inaccuracies are being transmitted from one author to another and that no system is being followed in the classification of these tumors. The author is indebted to Krauss, of Buffalo, N. Y., for a collection and tabulation of ninety-five cases, to which he may add, from his own experience, four cases, making a total of ninety-nine cases operated upon. This collection omits all cases antedating the Horsley-Gowers case, and all cases of Pott's disease in which subsequently there is developed a tumor of a tuberculous nature.

Classification.—Tumors affecting the spine, the spinal cord and its membranes, or any combination of these structures, may be divided under the following heads: (1) Vertebral; (2) extradural; (3) intradural; and (4) intramedullary.

The character of the new-growth may be either malignant or benign; it may be primary or may result secondarily from a similar growth situated elsewhere in the organism. The secondary involvement may be by metastasis or by direct extension. Schlesinger, in thirty-five thousand autopsies in the Pathological Institute at Vienna, found one hundred and seven cases of spinal tumors, the malignant variety being ten times as common as the benign. Harte says: "The vast majority of tumors of the spine are carcinomata that have either extended from neighboring organs or have developed as metastatic growths." On the other hand, Krause states that sarcomata are the most frequent, being present in six of the twelve cases reported in his series. Aside from these malignant forms of new-growth, the various forms of benign tumors, as well as parasitic cysts, are found involving the spinal column and cord.

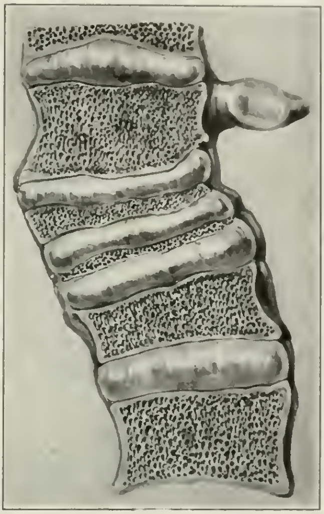

Fig. 368.—Malignant Disease of Vertebral Body, Followed by Settling of Spinal Column. (From Bland Sutton: "Tumors, Innocent and Malignant.")

(1) *Vertebral Tumors.*—Tumors affecting the body or the arch of a vertebra may be carcinoma, sarcoma, osteosarcoma, osteoma (exostosis), echinococcus, myeloma, and enchondroma. Of these, the most frequently observed is carcinoma, which invades the bodies of one or more vertebræ and produces gibbosity with obvious deformity of the spinal column. According to Fowler, these malignant tumors occur with greater frequency in the lumbar and cervical regions than in the dorsal, the bodies of the vertebræ are attacked, and the growth generally progresses rapidly. This occurs more frequently in females than in males and is secondary as a rule to malignant disease of the breast or uterus. Direct extension may occur from a focus located in the stomach or œsophagus or in the prevertebral lymph nodes. According to Bland-Sutton there is an aspect of this secondary form of malignant disease which is of interest. When a carcinoma

or sarcoma appears in the body of a vertebra, especially one of those of the lumbar set, the superincumbent weight will gradually efface the affected vertebra until finally two intervertebral discs come into apposition. (Fig. 368.) Guinon cites a case where the individual, who was thus affected, lost, as a result of this change, 9 cm. in height within eight months. Bliss reports a case (*Jour. Nerv. and Ment. Dis.*, Sept., 1905) of round-celled sarcoma of the spinal column in which it was found, at autopsy, that several vertebræ in the dorsal region had become disintegrated, and that in consequence the sound vertebræ had come closer together (Fig. 368), overlapping in places, and had produced an angularity in the cord. The pain which is set up by this "settling" may be severe. The writer has noted its occurrence in the cervical, as well as in the lumbar, portions of the spinal column.

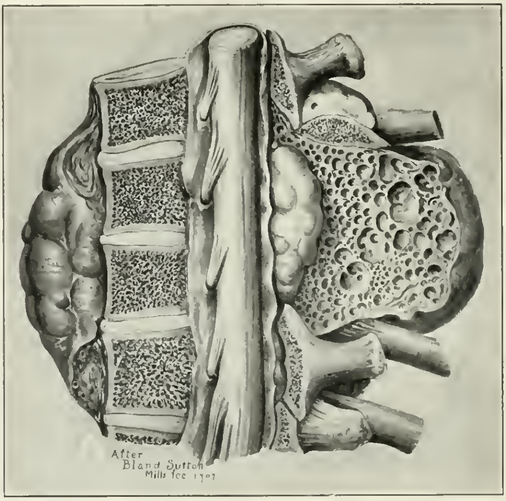

Fig. 369.—Extradural Tumor of the Spinal Cord. (From Bland-Sutton: "Tumors, Innocent and Malignant.")

(2) *Extradural Tumors.*—These tumors arise from the external surface of the dura, from the periosteum of the inner surface of the vertebral column, or from the extradural adipose tissue. (Figs. 369 and 370.) They may be carcinoma, sarcoma, lipoma, fibroma, angioma, lymphangioma, or endothelioma. The nonmalignant growths of this list produce a degree of pressure upon the cord which varies directly with the size attained. The malignant varieties produce characteristic destruction of the cord and its envelope by direct extension. In addition to these new-growths we have the simple and parasitic cysts, which may arise from the bone of the spinal column and, by pressure upon the cord, may produce the same symptoms as do the growths that actually spring from the cord.

(3) *Intradural Tumors.*—These tumors arise from the internal surface of the dura, from the arachnoid, from the ligamentum denticulatum, and from the pia. They include sarcoma, psammoma, neuroma, fibroma, neurofibroma, glioma, and gliosarcoma. Horsley reports a case in which he operated for well-marked paraplegia and discovered a mass of tissue which was determined to be thyroid-gland tissue, the patient having a goitre. Fowler states that lipoma of large size occasionally springs from the subdural adipose tissue and may be mistaken for spina bifida.

(4) *Intramedullary Tumors.*—The consideration of intramedullary tumors belongs principally to the neurologist, as they are not as a rule amenable to surgical treatment. They develop in the cord proper and are the most frequent of cord tumors. They may be gliomata and may not present the symptom-complex of a tumor of the cord but rather that of syringomyelia. They may have their origin primarily in the nerve roots, but are generally secondary to growths elsewhere. A pure sarcoma, fibrosarcoma, or myxosarcoma may arise either primarily or secondarily in the substance of the cord.

Relative Frequency of the Different Varieties of Tumors of the Spinal Cord.—From a study of the different collections of cases, it is found that the sarcoma is by far the most common tumor affecting the spinal cord. It was present in forty-five per cent of Bruns' cases, in forty-two per cent of Putnam's series, and in 29.4 per cent of the cases reported by Lloyd. The most frequently affected portion of the spine seems to be the thoracic, while the cervical is the least often involved. The location of the tumor is most frequently extradural; it is only in rare instances that the growth is located in the medulla. Of the extradural tumors collected by Krauss five were in the cervical region, thirteen in the dorsal region, and two in the lumbar region. Of intramedullary tumors one was in the cervical and two in the dorsal region. There were five tumors of the cauda equina, and of this number four were intradural.

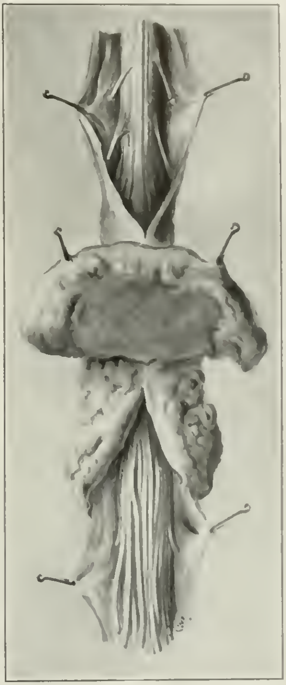

Fig. 370.—Sarcoma of the Spinal Cord and Vertebral Column, Resulting in Settling of the Vertebræ. (Dr Bliss' case.

Pathology.—The neoplasms which develop within the spinal column may be divided, as is indicated above, into tumors of the spinal marrow itself and tumors of the membranes which surround the spinal marrow. Of the tumors of the membranes, there are two types—the extradural and the intradural, named according to their seat. The tumors of the spinal marrow itself are, according to Schlesinger, the most infrequent. The tumors of the membranes are the most important clinically, and of these the intradural are the most frequent. Horsley discovered among fifty-eight cases that thirty-eight were intradural and twenty extradural in their situation.

The histology of spinal tumors needs but a word. In their structure these tumors do not differ from like tumors situated in other parts of the body. They are tough in their consistency, harder than the marrow, except in the case of diffuse extradural sarcoma, which may be soft and full of blood.

The size and shape of these tumors are matters of the greatest importance. The shape frequently conforms to the space in which they develop, which is narrow and offers more room for enlargement in length than in breadth. Intradural tumors are therefore generally small, hardly ever larger than a pigeon's egg. Growing lengthwise from what is at first a spherical shape, they become irregularly cylindrical and generally lie at one side, or to the back and at one side, rarely directly behind, and most rarely in front. There are also, in the intradural region, tumors which are long, string-like, and very slender, as noted by Oppenheim, Stertz, and others. When a tumor growing within the spinal canal breaks through the membrane and grows outwardly, which is a very rare occurrence, it finds room to enlarge and grow naturally as do tumors situated elsewhere. Tumors of the cauda equina, however, have room to grow to a considerable size without destroying the spine, and in this region the most varied and most malignant tumors are found. Tumors of the membranes of the spinal marrow possess the power to grow in three directions: first, they may invade the nerve roots, then the marrow, and lastly the bones. The bone lesions are generally not more than a slight erosion of the inner surface of the spinal canal, or there may be only slight changes in the periosteum where the tumor directly touches the bones. Atrophy of the bone, however, may result, and there may be acute angulation of the spinal column. Extradural tumors that are flat and that spread out over a considerable area may, during their whole existence, cause spinal root symptoms only. In some cases, however, they affect the marrow only after they attain a certain thickness. The sequence of symptoms resulting from a typical, circumscribed, round or cylindrical tumor within the dura is the following: first, those symptoms which are produced by a lesion of the roots, and then those which are due to encroachment upon the marrow. The symptoms of an intradural tumor are therefore distinguishable from those of an extradural growth only so long as the latter does not injure the marrow.

Generally speaking, the changes which take place in the spinal marrow when it is compressed by a tumor are identical with those which occur in the brain under like circumstances. In many cases in which the prognosis is favorable, the spinal marrow is simply compressed into a smaller space, and it loses its conductivity only during this compression and only on the side on which the tumor lies. In these cases the marrow remains anatomically in fair condition and does not lose its capacity for regeneration. Such a compression, however, cannot last for any great length of time without destroying the texture of the marrow, and thus rendering a return of function impossible; and yet the loss of conductivity during a period of many months does not justify the conclusion that the case is incurable, so far, at least, as the re-establishment of function is concerned. In certain cases the tumor does not merely cause a compression but produces a degree of softening of the spinal marrow which may lead to its total destruction. This softening, however, may be only partial and is usually most pronounced in the centre of the marrow; the condition being similar to what is observed in the brain, where a collateral œdema may exist for a long time without entirely destroying the nerve structures.

Tumors of the marrow itself—*i.e.*, intramedullary tumors—are generally single and are not large. They occasionally expand a good deal in the direction of their length. The gliomata sometimes enlarge transversely, producing transverse myelitis; more frequently, however, they develop at the periphery and cause one-sided root symptoms.

Etiology.—The origin of these tumors of the spine is often attributed by the patient to exposure to cold and sometimes to injuries. As has already been indicated, spinal tumors are frequently secondary to tumor growths elsewhere, the new invasion having taken place either by metastasis or by direct extension. Certain tumors, such as the lipoma and the dermoid, are presumably of congenital origin. The importance placed on injury as a causative factor is illustrated in the following case, which was reported by Putnam and Elliott (*Jour. Nerv. and Ment. Dis.*, Nov., 1903):—

The patient, 23 years of age, received a sudden twist of the neck while falling from a ladder. He walked a quarter of a mile after the injury and suffered for two weeks from pain in the neck. No other symptoms followed. Six weeks later, his neck was slightly injured again and became actively troublesome. In April, 1897, he was forced to give up work on account of severe pain in the neck. The month following he fell, perhaps because symptoms were coming on, and again painfully jarred his neck. From this time he was unable to run, though, for several months, he was still able to walk. The evidence up to this point makes it clear that the original injury was the primary factor in setting up the subsequent morbid process, and this seems more probable as he was never able to turn his head freely after the first accident, and less well to the left than to the right. Progressive symptoms developed and he was operated upon, a small giant-cell sarcoma being removed from the posterior surface of the axis, which tumor involved the dura and perhaps the cord itself.

In the ninety-nine cases to which the author has access, thirteen showed a more or less definite history of traumatism. It is impossible to say, however, what rôle traumatism plays as a causative factor in these cases.

Symptoms.—The symptom which occupies the most important place in the patient's mind is pain, which may be very severe or may simply be of a dull and heavy character; it may be intermittent or continuous; it may be localized or may extend about the trunk like a belt; it may come on very gradually or its onset may be sudden. Pressure upon the spine at the seat of the trouble may elicit pain, and when this result is obtained it is regarded by some authors as being a most important localizing symptom. In the reports of ninety-nine cases it was found that pain and tenderness along the spine were present in thirty-one, not present in fifteen, and not mentioned in the rest. The absence of pain and tenderness along the spine means nothing, but its presence means the involvement of the underlying cord, its posterior roots, or its membranes. This tenderness and pain may be localized on either the right or the left side of the spinous processes, or directly over them. Sometimes deep pressure is necessary to elicit this pain, while in other cases a light superficial touch or gentle percussion will cause it. The excruciating pain excited by unusual movements of the body or trunk is characteristic; but this sort of pain is common to other conditions, such as aneurism of the thoracic or the abdominal aorta. Woolsey says that slight pain across the shoulders and neck, produced by jolting, is an early symptom.* Pain, however, is sometimes entirely absent, as appears from the following report of a case:—

Sturnsburg † reports an interesting case of spinal-cord tumor in a man 48 years old. During the whole course of the disease there was never any pain or any suggestion of an irritative lesion. The legs showed a spastic paresis with all the signs that usually accompany such a condition—Babinski phenomenon, clonus, etc. Sensation was from the beginning much involved, so that the localization of the tumor was made possible by this alone. The tumor was localized at the tenth dorsal segment, and it was found at that place and removed without difficulty. The author draws the following conclusions from this experience: In the presence of symptoms which point to the existence of a pathological process in the spinal cord,—symptoms furthermore which seem to indicate that the original location of the lesion does not alter but that the lesion itself continues to grow,—we are justified in suspecting an extramedullary growth, and in advocating its surgical removal even if during the whole course of the disease neither pain nor irritative symptoms are present.

Aside from pain there are weakness of the extremities, disturbance of coordination, girdle sensations, respiratory difficulty, sphincter disturbances, disturbances of the temperature sense and the sense of touch, tremors, and sensory disturbances which indicate at what levels in the spinal canal the pathological process is active.

Spinal Localization.—Through the labors and investigations of Kocher, Wichmann, McKenzie, Sherrington, Sieffer, Reed, Head, Oppenheim, Thornburn, Starr, and others, the knowledge of the segmental distribution of the posterior spinal nerves has been advanced to such a point that a reasonably accurate boundary or zone is recognized for the peripheral nerve distribution. For instance, the third, fourth, and fifth cervical segments give origin to the phrenic nerve; at the fifth, sixth, and seventh cervical segments the posterior thoracic nerve comes off; the seventh and eighth cervical and the first dorsal segments

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* Presby. Hosp. Rep., Jan., 1904, vol. vi.

† Deut. Zeit. f. Nervenhkd., Bd. 32, Heft 2 and 3.

give origin to the dilator pupillæ; and the nervous supply of the umbilicus probably originates at the tenth thoracic segment. In like manner the reflexes of the bladder and rectum, of the knee jerk, etc., will doubtless in time be utilized in determining the seats of certain lesions in the spinal cord. For clinical purposes the sensory localization is much more accurately determined than the motor localization. (See also Vol. I., page 543.)

According to Sherrington the area of skin belonging to each central spinal nerve root overlaps the skin areas—one in front and one behind—of the neighboring spinal nerve roots; and these two overlaps are termed respectively the anterior overlap and the posterior overlap of the sensory root field or area. Harte says that the science of spinal localization has now reached such a degree of accuracy that it is a comparatively easy matter to determine, by the localizing symptoms, the exact portion of the cord involved. In practice, however, the correctness of this statement is not entirely borne out by the facts; for, in certain cases, an operation is performed and no tumor is found at the spot where, according to the symptoms, it should exist, while, at a subsequent post-mortem examination, it is discovered that the growth is located at a point some distance above the upper limit of the operation. It may be that this confusion arises from the overlapping of the sensory fields; and it may also be due to the fact that there is no known method by which the extent of a lesion or its lines of greatest pressure can be accurately determined. All authorities agree that a thorough knowledge of the topographical anatomy of the spinal cord is necessary for the proper recognition and localization of a spinal tumor. It is necessary also to have a thorough knowledge of the functions of the brain. According to Cushing, it is especially the small and removable spinal tumors which put one's knowledge of localization to the test. Fortunately, the primary growths are usually of a benign nature and spring from the meninges; they are susceptible of being enucleated, and, if removed early, allow of complete restoration of function to the cord. These meningeal tumors are by no means rare, and the fact that a larger number have not been recorded is due possibly to mistaken diagnoses. According to the same authority, explorations have been lamentably rare and localization has too often been incorrectly made. A single visit to the laboratory of the Queen's Square Hospital, London, and a view of the tumors of this nature which are there preserved, enable one to realize how frequently in other parts of the world they must have been overlooked. (*Bul. Johns Hop. Hosp.*, 1905.)

DIAGNOSIS.—The symptoms of a spinal-cord tumor depend on the region of the cord involved as well as upon the particular segment. As each segment of the spinal cord has a fairly definite peripheral distribution of its sensory nerve fibres, and as each superimposed group of segments has just as definite a peripheral motor-nerve distribution, it is possible to establish by careful physical examination the location of the tumor. Spinal-root symptoms consist of pain and the disturbance of the normal sensory response to external stimuli; spinal-cord symptoms take the form of motor paralysis, sensory paralysis, rectal, vesical, and tendon-reflex changes. It must be borne in mind that there are on record cases in which pain was not present, as well as cases in which the character of the pain complained of seemed to be of an hysterical nature. In such cases the diagnosis will necessarily remain doubtful. In a private communication from Dr. S. I. Schwab, the following report of a case is given:—

> The patient, a man 38 years of age, presented symptoms of hysteria and of a tumor located in the cervical part of the cord. The hysterical sensory changes so masked the sensory disturbances produced by the cord lesion that it was impossible to interpret them except upon a functional basis. In this case there was a remarkable variation in the constancy of the deep reflexes, and there were also an atypical Babinski reflex, an ankle clonus, and a remarkable series of extensor contractures in all extremities. These manifestations were typical of hysteria and disappeared readily when the patient's attention was taken from them. The ankle clonus disappeared entirely at intervals. The disturbances in sensation were a total anæsthesia in both arms, extending half-way to the elbow (the line of demarcation was bilaterally exact and sharp), and a zone of anæsthesia which extended around the chest and the upper boundary line of which ran through the tips of both shoulders behind and through points situated at about the same level in front. In consideration of all these facts and of the uncharacteristic location of the pain, a diagnosis of hysteria was made. At the autopsy, an endothelioma, the size of a pecan, was found lying outside the dura, on the right side, at the level of the third and fourth cervical segments.

The pain of hepatic colic, of pleurisy, of sciatica, and of rheumatism, may at times resemble very closely that caused by a spinal new-growth. The appearance of herpes zoster, which indicates an involvement of the posterior ganglion, adds much to the trouble of making a positive diagnosis. The presence of Brown-Séquard paralysis has been frequently noted and is indicative, in a general way, of a unilaterally located tumor involving the motor tract on one side and the sensory tract on that same side, but causing sensory changes on the other side by virtue of the crossing of sensory fibres. All the objective symptoms may vary, and both pain and temperature sense may be diminished; the reflexes may at times be plus and at other times minus. Munro and Oppenheim have both observed the presence of œdema, and the latter has observed retraction of the umbilicus.

Tumors involving directly the anterior portion of the cord are extremely rare, and they should present as symptoms motor disturbance, atrophies of the muscles, and trophic changes.

Hysteria, neurasthenia, and neuralgia should be considered in making a diagnosis; but these conditions usually present characteristic signs and yield to treatment.

Spinal caries in its early stages may present symptoms that closely simulate those of tumor. Observation, however, and a thorough examination of the sensory phenomena will make the differentiation between these two conditions quite clear.

Transverse myelitis often presents a symptom-complex so very similar to that of a spinal tumor that a differential diagnosis between the two is impossible. Nonne* reports a case where a laminectomy was done for a supposed spinal tumor, but no such tumor was discovered. Later sections of the spinal cord showed that it was the seat of multiple sclerosis.

Early symptoms are of little aid in establishing a diagnosis. Only after the cord has been involved—either by direct invasion or by the pressure exerted by an adjacent growth—to such a degree as to furnish well-marked physical signs, is it possible to make a diagnosis.

It is not possible to make a differential diagnosis between intramedullary and extramedullary tumors, as there are no symptoms or signs which will enable one to determine the exact relationship of the growth to the dura, or to decide whether it is intramedullary or extramedullary.

In the majority of cases so far reported the tumor was located posteriorly and to the right. A difference in the spasticity of the legs or a predominance of the sensory symptoms on one side or the other will aid in establishing the location of the tumor to the right side or the left of the spinal cord.

Prognosis.—Putnam and Warren,† who have tabulated thirty-six cases, three of which were original, reach the conclusion that surgical intervention does no good in the majority of intraspinal tumors. In twelve cases a fatal termination was hastened by operation; in nine cases a slight change for the better was noticed after operation; in ten cases recovery took place. In some of the cases which ultimately resulted fatally, pain was relieved by the operation. Oppenheim ‡ gives the following report of his experience with the operative treatment of spinal-cord tumors:—In twelve cases in which he made a correct diagnosis, the tumor was discovered and removed entire. In six of these cases the operation resulted in cure; in the seventh, the result was doubtful; in five cases the patient died, but these particular operations were performed a long time ago.

Harte, in 1905, submitted to the American Surgical Association, a tabulation of ninety-two cases which had been operated upon; in forty-three of these the patient died—a mortality of forty-seven per cent. If we omit the cases, seventeen in number, that would have terminated fatally in any event (operation or no operation), the surgical mortality is reduced to twenty-six per cent. Harte also points out that the mortality among females is forty-five per cent and among males fifty-seven per cent, and he explains this by calling attention to the fact that sarcoma is found one-third oftener among males than among females.

Putnam, Krauss, and Park § state that, in ten, perhaps twelve, of the operations which they have reported, death seemed to have been hastened thereby, and that, in nine of the cases, the operation seems to have made little difference in the progress of the disease. The percentages of recoveries in Bruns' and Lloyd's collections of cases are practically the same, being thirty per cent in the former and 31.37 per cent in the latter. In the collection of cases made by Putnam and Warren the percentage of recoveries is lower, being 21.3 per cent, while the percentage of improvement is also 21.3 per cent. It should be stated that no case has yet been reported where recovery has followed the removal of an intramedullary tumor; neither has a tumor been successfully removed from the ventral side of the cord. As a general rule, the higher up in the cord the tumor is situated the less is the chance of its being removed successfully and of the cord regaining its conductivity if it has undergone compression.

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* Monat. f. Psych. u. Neur., Nov., 1907.

† Am. Jour. Med. Sci., Oct., 1899.

‡ Monatsch. f. Psych. u. Neurol., Nov., 1907.

§ Am. Jour. of Med. Sci., Jan., 1903.

Treatment.—When a reasonable number of the symptoms of spinal-cord tumors are present, the surgeon is fully justified in operating upon the region which the clinical phenomena indicate to be the seat of the disease. The treatment of spinal tumors is purely surgical, and the cases may be divided into those which are operable, those which are inoperable, and those in regard to which the outcome of surgical intervention is doubtful. In the first class may be included all cases of non-malignant growths (either extradural or intradural) which can be removed without encroaching upon or opening the medullary substance of the cord. To the inoperable cases belong the malignant growths which involve the cord proper or its membrane, and which are of primary or secondary origin; also those growths which spring from the spinal arch and involve the cord by direct extension. To the third class belong many cases which may be relieved by laminectomy, by division of nerve roots, or by division of the cord itself, as advised by Cushing. He reports a case where this operation was done as a palliative measure, the patient and her husband both recognizing the fact that the excessive severity of the pain had been considerably lessened as a result of the operation. In all cases of spinal tumor where the disease has not involved too extensively the surrounding parts, laminectomy should be done at the very earliest possible moment, for the conditions in these cases are such that a destruction of the cord from pressure, which increases *pari passu* with the growth of the tumor, is imminent. When for any reason a laminectomy cannot be done for the purpose of relieving the intense suffering, a division of the roots of the sensory nerves at or near their exit from the spinal canal should be made. Cushing reports a case where the patient, whose spinal cord had been invaded by some form of new-growth, was almost entirely relieved of his suffering by a laminectomy and the removal of as much of the growth as was accessible. Putnam and Elliott show that an operation, even when it does not cure, often alleviates the extreme suffering which these tumors entail. When the lower part of the cord is involved, we are justified in dividing the cord above the seat of the lesion and (according to Putnam and Elliott) in dividing the nerve roots also. While the operation of laminectomy for the removal of spinal tumors has not yielded, up to the present time, very flattering results, this lack of success is due in some degree to the fact that, as in the case of tumors of the brain, the patients thus affected do not come under the care of the surgeon until the disease has extended beyond the stage when good results may with reason be expected. As this subject, however, becomes better understood earlier diagnoses will follow; and, besides, the patient and the patient's friends will in time come to recognize the fact that surgery alone affords some chance of relief or cure.

Williamson* has tabulated fifty-one cases of extradural and intradural spinal tumors, all of which were successfully removed by operation. Were it not for the large amount of space which this carefully made analysis occupies, I should be glad to reproduce it here.

After the diagnosis of tumor of the cord has been made, in any given case, the question next arises, What is the surgeon's duty? Is he to operate at once on every case; or is he to wait for confirmatory symptoms, such as signs of degeneration or extension of paralyses? Before these questions can be properly answered it will be necessary to consider other aspects of the problem—as, for example, the dangers of an operation, the probability of the tumor being removable, and whether, if it should be found not to be removable, the patient would derive a measure of relief from a palliative operation. The longer operative interference is postponed, the fewer become the chances of the patient's recovery. Then, in addition, the possibility that a tumor is syphilitic must be considered. The employment of antisyphilitic treatment has, in the past, been the cause of much delay, and is responsible for many of the bad results which follow operation. It is self-evident that the surgeon must have a fairly definite idea of the location of the lesion before he attempts operation, and he must also give due weight to the fact that in these cases the tendency in the past has been to operate at a spot considerably lower than the one where the lesion is subsequently found to exist. If, therefore, he fails to discover the tumor at the spot where he expected to find it, he should not hesitate to push the exploration in an upward direction. Failure to adopt this course has, in several instances, resulted in the discovery of the tumor, after death, at a point only a short distance above the upper limit of the field of operation.

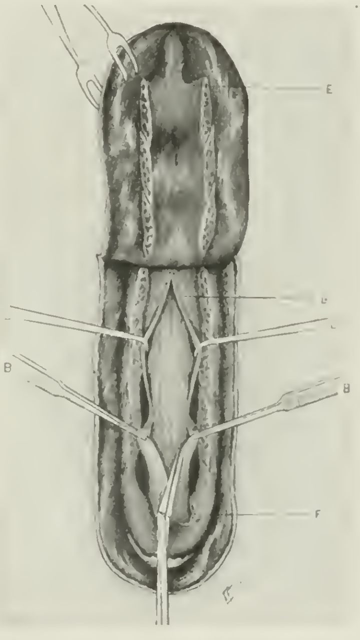

FIG. 371.—Bickham's Osteoplastic Flap Reflected Upward, Dura Incised and Retracted, and Cord Exposed. (*Annals of Surgery*, 1905, p. 388.)

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* Williamson: "Diseases of the Spinal Cord," London, 1908.

Operative Technique.—Laminectomy.—The late Dr. McCosh* gives the following general suggestions in regard to spinal surgery: "(1) The incision should be made as high as possible. The main reason for this is that the nutrition of the soft parts below the seat of the lesion may be impaired because of destruction of the nutritive cells in the cord. Another reason of less moment is that the lesion has been found above rather than below the point of its location in the majority of instances.

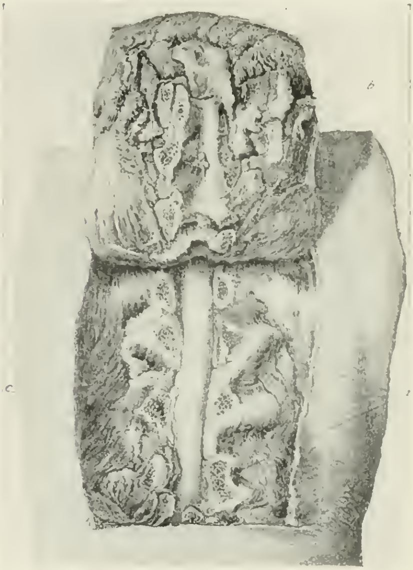

Fig. 372.—Urban's Osteoplastic Resection. (von Bergmann, Bruns, Mikulicz, and Murphy: "Handbuch der Chirurgie.")

"(2) The operation should be done rapidly. But few vessels need the application of artery clamps and still fewer that of ligatures. If a bold incision be made, the bleeding will not be great and can be controlled by the use of gauze pads held down by broad retractors. At times it may be necessary to pack one side or end of the wound with sponges and, while these remain for a minute or two, the operator can work at some other part of the wound.

"(3) Ample space should be afforded for proper examination of the cord. For this purpose the removal of at least three laminæ is generally necessary. Of course, in cases of fracture, bullet or stab wounds of the cord, the removal of one or two laminæ may suffice; but, at least in cases of tumor, one should be careful not to be hampered by too small an opening.

"(4) Support of the spinal column, after operation, by means of braces or plaster-of-Paris jackets has not seemed to me necessary; indeed, as it appears to me, it adds only to the discomfort of the patient. An experience of nearly twenty laminectomies has convinced me that it is generally useless."

There are two methods of operating for exposure of the spinal cord.

(1) First Method.—In this method a vertical incision is made through the skin down to the tips of the spinous processes and then the muscles attached to these are divided and separated from the bone until the arch of the vertebral column is well exposed. Afterward the spines and laminæ are removed by bone forceps, and no effort is made to save the fragments for

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* Jour. Amer. Med. Assoc., Aug. 31st, 1901.

replacement at the close of the operation. Many ingenious instruments have been devised for the purpose of cutting through the posterior bony arch of the spine. Saws, both hand and electrical, have been employed. These instruments, although they hasten the completion of the operation, are accompanied by the dangers which speedy operating entails. Most surgeons find the rongeur forceps well adapted to the needs of this operation, both as regards its capacity for accomplishing speedy results and as regards the safety with which it may be used.

(2) Second Method.—The second method of exposing the spinal cord is by making what is called an osteoplastic flap (Figs. 371 and 372)—*i.e.*, a flap which consists of skin, muscles, and the arches of the vertebræ. If single, the flap remains attached to a hinge situated at one or the other side or at the end; but, if the flap is double, the hinge is placed in the middle. The advantage of this method is that the flap of bone may be replaced, thus rendering it possible for the bony arch to be completely restored. Its disadvantages are that it consumes more time, that it is more bloody, that it gives less satisfactory access to the cord, and that it causes irritation to the nerve roots through the pressure produced by callus or imperfect adaptation of the bony surfaces. Laminectomy in the cervical, and perhaps also in the lumbar region, is more difficult to perform than in the dorsal region of the spine, as in this latter region the spine is convex posteriorly (kyphotic). Sherman* states that he asked the opinion of the following men (Bevan, Binnie, Willard, Cushing, Bloodgood, Munro, Moore, McArthur, Bradford, McCosh, Richardson, Gibney, and Abbe), whose names have been associated with spinal surgery, regarding the choice between plain laminec-

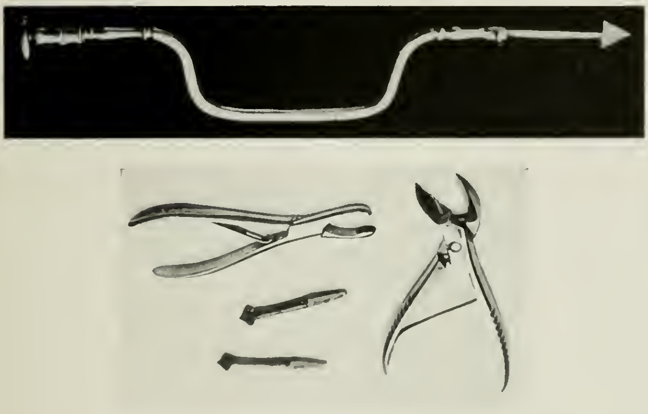

FIG. 373.—Instruments Used in Laminectomy. (From Murphy, "Neurological Surgery," in *Surg., Gyn., and Obst.*, April, 1907.)

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* Jour. Am. Med. Assoc., March 7th, 1907.

tomy and the osteoplastic operation. The replies which they gave were unanimously in favor of simple laminectomy, unassociated with any osteoplastic procedures. They expressed some difference of opinion, however, as to the choice of instruments for cutting the laminæ, some preferring the chisel, while others favored the forceps or rongeurs. (Fig. 373.)

Cushing has added an important fact to our knowledge of this subject, in reporting that, on doing a second laminectomy on a patient upon whom he had already performed the same operation one year previously, he discovered that new arches had already formed from the conserved periosteum.

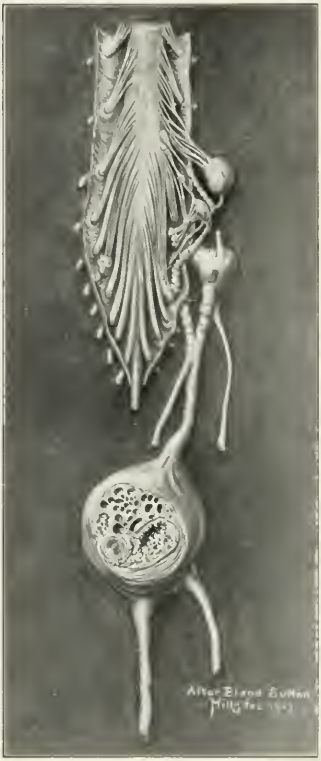

FIG. 374.—Tumor of the Cauda Equina and Anterior Crural Nerve. (From Bland-Sutton: "Tumors, Innocent and Malignant.")

Spinal Cysts.—Cysts which cause spinal compression are, as a rule, external to the dura mater. They develop in the adipose tissue which lies between the dura mater and the bone of the vertebral arches. They are always unilocular and vary in size from a pea to a walnut. At times they may be numerous. The simple non-parasitic cysts are exceedingly rare. Parasitic cysts are usually hydatids or cysticerci. The symptoms produced by cysts are those of meningeal tumor, that is, of compression myelitis.

The only treatment that is of any service is the performance of laminectomy and the excision of the cyst or cysts.

VI. TUMORS AND DISEASES OF THE CAUDA EQUINA AND CONUS TERMINALIS.

Tumors of the Cauda Equina.—The new-growths which involve the cauda equina are evidenced as a rule by severe pain in the region of the sacrum, the bladder, and the rectum, and especially by pain along the course of the sciatic nerves—bilateral sciatica. The muscles supplied by the sacral plexus may become paralyzed, showing marked atrophies and even the reaction of degeneration. At times the bladder and rectum may be paralyzed. An anæsthesia may develop in the distribution of the sciatic plexus, and the plantar reflexes and tendo Achillis reflexes may be absent. The knee jerks, however, are generally present. Spiller* says that, in making a diagnosis in these cases, it will be necessary to rule out hysteria, multiple neuritis confined to the lower limbs, intrapelvic tumor, tumor or caries of the lumbar vertebræ or sacrum, lesions within the vertebral canal but external to the dura, and tumor or other lesion of the conus terminalis. The diagnosis, as a rule, can be made only with the aid of the neurologist. It may be said, however, that bilateral sciatica is usually indicative of tumor. In tumor of the cauda equina, the pain is often unilateral at first, but it soon becomes bilateral.

The treatment of a tumor of the cauda equina consists in excising the new-growth after a careful diagnosis has ruled out the possibilities above-mentioned. The prognosis for operation is not good, and in some cases it is advisable to cut the posterior roots in order to relieve pain.

Disease and Injuries of the Cauda Equina.—The cauda equina may also be the seat of syphilitic gumma, of meningitis, or of abscess from tuberculous bone disease. It may be injured, as by fracture or dislocation of vertebræ, by a bullet wound or by a wound inflicted by a penetrating weapon. The chief symptoms are paralysis of the leg muscles supplied by the sacral plexus, paralysis of the bladder and rectum, pain in one or both sciatic nerves, anaesthesia of mucous membranes of bladder, urethra, and rectum, and anaesthesia in the distribution of the sacral plexus. The treatment of these diseases or injuries consists of operation to relieve pressure or supply drainage. Cutting of the nerve roots to relieve excessive pain is also sometimes required.

Diseases and Wounds of the Conus Terminalis.—The extreme end of the spinal cord is known as the conus terminalis or conus medullaris. It lies behind the body of the second lumbar vertebra, and is so placed that a knife passed between the first and second lumbar vertebræ would cut the base of the conus terminalis. From it arise the nerve supplies of the rectum, perineum, urethra, and bladder. Its chief pathological lesion is that due to trauma, which sets up a traumatic myelitis.

The diagnosis of affections of the conus, as differentiated from those of the cauda equina, is difficult, as there are many symptoms which are common to both. The sudden onset of symptoms after an injury to this part of the spinal cord, points to lesion of the conus. The treatment of injuries here sustained consists of rest and protection of the injured part, or surgical intervention.

* Spiller, W. G., in Am. Jour. Med. Sci., March, 1908.

SURGICAL DISEASES AND WOUNDS OF THE FEMALE BREAST.

By HARVEY G. MUDD, M.D., St. Louis, Missouri.

I. ANATOMY AND PHYSIOLOGY OF THE FEMALE BREAST.

THE breast, genetically an aggregation of highly specialized sebaceous glands, is developed from the external germinal layer by an ingrowing of the rete Malpighii into the cutis vera in early fœtal life. At birth we find already formed a cluster of tubes, fifteen to thirty, with club- or flask-shaped ends radiating from the common point of ingrowth, and held together by a network of areolar and connective tissue enclosing considerable fat in its meshes. The fully formed mamma is made up of from ten to twenty lobes representing as many compound racemose glands, each pyramidal in shape, with ducts converging toward the nipple; the whole embedded in a stroma of connective tissue.

The nipple is ordinarily raised somewhat above the surface of the breast and is covered, as is its areola, by a very delicate skin. It receives the milk ducts, generally from fifteen to twenty in number, which empty into it by very fine openings. The areola presents numerous sebaceous glands, which become conspicuously prominent during pregnancy and lactation—tubercles of Montgomery. The nipple and areola contain also numerous bundles of unstriped muscle fibres, both radiating and circular; when irritated these fibres contract, making the nipple firmer and more prominent.

The mammary gland lies within the superficial fascia, which divides into two layers for its reception. It rests upon the pectoral fascia, to which it is loosely connected by processes of connective tissue. Beneath the gland is found a varying amount of fat, which in some cases may make up a great part of the entire prominence of the breast. The anterior fascial layer is intimately connected with the overlying skin by connective-tissue bundles, and it sends also numerous fibrous prolongations into the stroma of the gland—ligamenta suspensoria of Sir Astley Cooper.

Until puberty the breasts develop alike in both sexes, and there is but little difference in the external appearance. In the male the development of the breasts ceases at puberty, and after the age of thirty they undergo retrogressive changes. In the female there is marked increase of growth at this epoch, although comparatively few new acini are developed, and those mainly at the ends of the ducts and lateral tubes.

Studying the changes in the female breast at puberty, J. Collins Warren has observed the development of a hyaline connective-tissue stroma along the course of and surrounding the ducts and tubes,—a stroma which is both more transparent and richer in nuclei than the fully developed connective-tissue stroma of the gland. New acini are developed in this stroma by a lateral budding of little processes of epithelial cells, at first solid and later showing cavities as in the fully formed glandular structure. The investigation sheds new light on the question of the origin of neoplasms of the breast.

The enlargement of the breasts at the period of the appearance of the menses is due not only to increase of the glandular structures, but in part also to the formation of a cushion of fat under the skin, adding smoothness and rotundity to the virgin breast. During pregnancy and lactation the breasts increase enormously in size through the development of a large amount of new gland tissue, the areola loses its pink color and becomes darkly pigmented, and the cutaneous glands of the areola take on a notably increased prominence. Early in lactation there is sometimes considerable enlargement of the related lymph nodes. During lactation the mammary gland reaches the height of physiological increase. After lactation is ended the acini collapse, the breasts become flaccid, sometimes even pendulous, and the smooth plumpness of the virgin breast is superseded by a granular or lobulated condition of the organ. After the period of full maturity comes the stage of retrogression, most marked at the time of the menopause; the acini undergo atrophy, the glandular epithelium disappears, and only the ducts remain. As the gland structures disappear, their place is taken by connective tissue and fat, which in old women make up almost the entire volume of the breasts.

The fully developed breast extends from the third to the sixth or seventh rib and from the margin of the sternum to the anterior border of the axilla. Its general form is that of a hemisphere obscurely triangular at the base, where it spreads out a little in an upward and inward direction toward the sternum, and above and below outwardly toward the axillary border. Not infrequently string-like processes or cusps reach out to variable distances in different directions, as toward the sternum and toward the axilla. The extreme upper and outer portion, extending along the pectoralis major muscle in the direction of the axilla, is closely associated with the axillary lymph nodes and sometimes connected but slightly with the main body of the gland.

Processes of gland tissue may extend also along the suspensory ligaments of Cooper; and Heidenhain has found connective-tissue projections which contain glandular epithelium and extend into the septa between the larger divisions of the pectoralis major. The mammary gland, as Oelsner has pointed out, is sharply outlined below; the skin being here connected with the underlying structures by short, firm bands of connective tissue with very little fat.

Vascular Supply.—The arterial supply of the breast is derived mainly from the subclavian and axillary arteries, the outer and lower portions receiving also branches from the long thoracic. The internal mammary sends perforating branches to the gland through the second, third, and fourth intercostal spaces, and small branches are distributed to it from the aortic intercostals, from the acromio-thoracic, from the superior thoracic, and, through its free anastomosis with the internal mammary, from the deep epigastric artery.

The venous return from the mamma is by venæ comites of the several arteries, and mainly by the way of the internal mammary and long thoracic veins. The subcutaneous veins are large; some passing over the clavicle to terminate in the external jugular, others emptying into the cephalic and axillary veins. The subcutaneous veins anastomose very freely, and often form a circle beneath the areola—circulus venosus of Haller—by which the blood is returned from the nipple.

Nervous Supply.—The breast receives filaments from the sympathetic, and from the perforating branches of the intercostal nerves. The nerve supply of the integument of the breast is derived from the supraclavicular nerve and from the lateral and perforating branches of the second, third, fourth, fifth, and sixth intercostal nerves. The connection of the lateral cutaneous twig of the second intercostal (intercosto-humeral) with the lesser internal cutaneous nerve—nerve of Wrisberg—is important, as explaining the severe pain which often extends down the arm in many cases of mammary cancer. Other extensive nerve communications similarly explain the widespread pains so common in mammary growths. Severe "neuralgic" pains, referred to the mamma and pectoral region, may originate also from irritation of nerve trunks or roots not immediately connected with the breast—as, for instance, in caries of the vertebræ, intrathoracic growths, malignant disease of the œsophagus or stomach, etc.

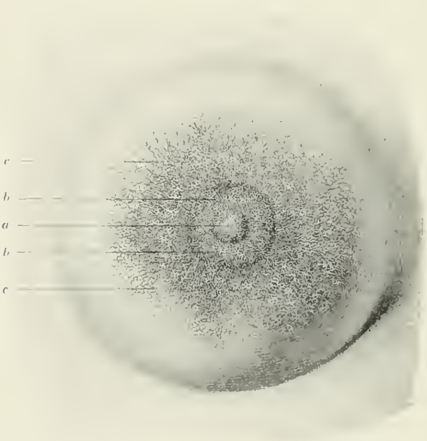

FIG. 375.—Superficial Lymphatics (Injected) of Nipple and Areola. (From Sappey.) *a*, Lymphatic network of the skin covering the nipple; *b*, *b*, lymphatic network of the skin covering the areola; *c*, *c*, lymphatic network of the skin about the areola. The illustration shows that the lymphatic network of the skin of the nipple and areola is very highly developed and that, beyond the skin covering the central portion of the breast, the lymphatic network is progressively less well developed.

Lymphatics.—The distribution of the subcutaneous lymphatics at the periphery of the breast is the same as beneath the adjoining skin of the anterior thoracic wall, the finer ducts terminating in collecting trunks which carry the lymph to the nodes in the axilla. (Fig. 375.) Over the central portion of the breast the subcutaneous lymphatics form a fine network, from which numerous small trunks pass at once into a plexus of larger lymph vessels under the nipple and areola—the subareolar plexus of Sappey. (Fig. 376.) The greater number of the trunks from the mammary gland terminate also in this subareolar plexus.

The lymphatics of the mammary gland proper ramify on the surface of the glandular lobules and galactiferous ducts, the collecting lymph channels passing between the ducts to become merged in the subareolar plexus. From this plexus usually run two large trunks, the one to the inner and the other to the outer side. These receive other trunks, from the superior and inferior portions of the gland, and terminate in the axillary lymph nodes. Certain accessory channels are sometimes present. In thirty subjects injected by Grossman, such an accessory channel was found three times; he describes it as passing out from the posterior surface of the mamma, perforating the pectoralis major, and continuing between this muscle and the pectoralis minor to the subclavian group of lymph nodes. A more important accessory channel, described by Stiles, Gerota, Poirier, Oelsner, and others, is formed by trunks emerging from the inner side of the breast along

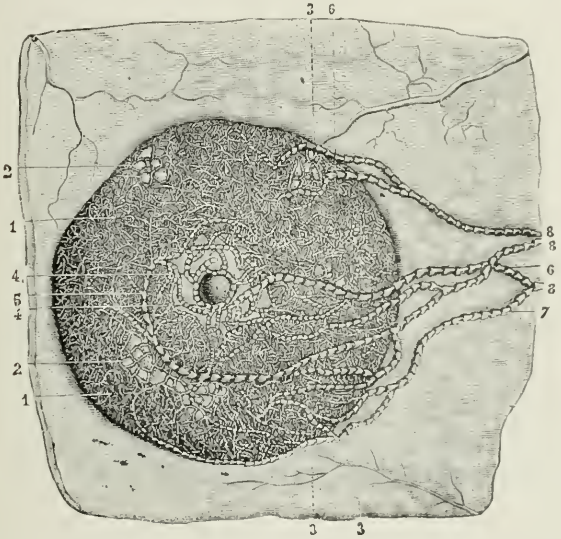

Fig. 376.—Lymphatics of the Female Breast. (From Sappey.) 1, 1, Lymphatic network of the anterior surface of the mammary gland; 2, 2, lobules of the mammary gland, the peripheral lymphatic network of which has not been injected, in order to render more prominent the circumlobular network which surrounds the lobules; 3, 3, trunks which arise from the upper and lower portions of the mammary gland; 4, 4, lymphatic plexus under the areola; 5, lymphatic vessel which arises from the internal part of this plexus and which takes a semicircular course to reach the axilla; 6, another vessel arising from the outer part of the same plexus and running directly outward; 7, lymphatic vessel arising from the lower part of the gland and uniting with the preceding to form one of the two trunks into which all the other vessels empty; 8, 8, vessels arising from the internal part of the subareolar plexus and from the upper portion of the breast converging to form the second of the two trunks which empty into the axillary lymph nodes.

the track of the arterioles given off by the internal mammary artery and perforating the pectoralis major and intercostal muscles to terminate in the nodes of the anterior mediastinum. Cross-anastomoses of the lymphatics along the median line make it possible for the lymph from one side to find its way to the nodes of the opposite side of the body. Furthermore, some of the lower cervical nodes receive lymphatics from the axilla and, to some extent, from the skin over the breast.

A brief summary of the arrangement of the axillary lymph nodes is necessary for a clear understanding of the subject of carcinoma of the breast. In general, the axillary nodes receive the lymphatic vessels draining the skin of the upper part of the trunk and the upper extremity, the derivatives of the skin including the breast, and the subjacent muscles. The axillary nodes as described by Poirier, Cunéo, and Delamere are arranged in several chains which converge toward the apex of the axillary space. At the base of the axilla we recognize (1) a humeral chain extending along the external wall in the track of the great blood-vessels, (2) a thoracic chain accompanying the external mammary artery (longer external thoracic) along the internal wall, and (3) a scapular chain, accompanying the subscapular artery along the posterior wall. Between these chains is a group of nodes, the central group, connected with all three chains by numerous anastomoses. Of the several chains the scapular becomes merged in the humeral, and this in turn blends with the thoracic chain to form the subclavicular group which lies at the apex of the axillary space near the point where the axillary vein passes under the clavicle and just above the upper border of the pectoralis minor muscle. The nodes of the humeral chain receive afferent vessels from the superficial and deep lymphatics of the arm. Those of the thoracic chain receive the lymphatics of the skin and subjacent muscles of the anterior and lateral regions of the thorax, and the lymphatics of the breast. Those of the scapular chain receive the lymphatics of the integument and subjacent muscles of the lower part of the neck and of the posterior and dorsal scapular region. The central group is in communication on the one hand with the humeral, thoracic, and scapular chain, and on the other with the subclavicular group. The subclavicular group receives few or no direct efferent lymphatics, but it gathers in almost all the efferent trunks from the axillary lymph nodes collectively. The efferents from the subclavicular group form in turn a plexus, the infraclavicular plexus, whose efferents unite to form the subclavian trunk, which empties into the subclavian vein near its junction with the internal jugular. It must be borne in mind, however, as pointed out by Poirier, Cunéo, and Delamere, that the arrangement of the lymphatics is very complex; and that any description of the various groups of nodes and their connections is necessarily more or less dogmatic, and is subject to numerous variations and exceptions in individual cases.

II. DISEASES AND WOUNDS OF THE FEMALE BREAST.

Affections of the Nipple and Areola.—The thin and delicate skin of the nipple and areola is easily damaged by mechanical irritation, as in suckling an infant. Fissures of the nipple are extremely painful, the intense smarting when the child is put to the breast often rendering suckling impossible. They also offer an avenue of entrance for bacteria, and are thus causative factors in the production of mammary abscess. To guard against fissures and excoriations, the nipples should receive careful attention during the latter weeks of pregnancy. They should be bathed daily or several times a day with cold water, alcohol, or lead water, or they may be painted alternately with alcohol and glycerin. During the period of nursing extreme care and cleanliness are requisite. Before the child is put to the breast, the nipple should be bathed with alcohol and rose water, equal parts, or with a solution of boric acid; after nursing, it should be carefully washed, and a solution of borax or of boric acid, or a weak astringent solution of alum or of lead acetate, applied. It should then be carefully dried, and painted over with a protective coating of flexible collodion or powdered with zinc oxide. The use of a nipple shield may be necessary in severe cases. Fissures are sometimes benefited by touching them with a point of lunar caustic, or by painting them with compound tincture of benzoin. Eczema about the nipple and areola, often associated with a lack of cleanliness, may spread widely over the gland, and is sometimes persistent. An intractable eczematoid condition of the nipple and areola is also sometimes the precursor of carcinoma (Paget's disease).

Local syphilitic infection, about the nipple, may occur from suckling an infant with syphilitic sores in the mouth or on the lips. Secondary syphilitic affections of the nipples in syphilitic women, oftenest moist condylomata, are more common. If nursing, the child should be removed from the breast, and the woman put on antisyphilitic treatment.

Retention cysts occasionally develop in the areolar sebaceous glands; and cases of epithelial carcinoma of the nipple, probably originating in a sebaceous follicle, have been reported. Cases of true hypertrophy of the nipple, of fibroma pendulum papillomatosum and of angioma cavernosum pendulum of the nipple have been observed.

Retraction of the nipple may be congenital, due to developmental error, or may result from cicatricial contraction following ulceration, burns, and the like. A few cases of congenital retraction have been reported as improved by operation.

Amazia and Polymazia (Polymastia).—Congenital absence of a mamma (true amazia) is very rare, and is generally associated with imperfect development of some part of the sexual organs and with absence of the pectoral muscle. A case of complete absence of both breasts is reported by Voglie; in this case the woman became pregnant. Cases of complete absence of the nipple (athelia) are also very rare. Imperfect development of the breast is more frequent, the gland remaining infantile and undergoing no enlargement at puberty. Supernumerary breasts and nipples (polymastia) occur frequently in both sexes. There may be supernumerary breasts with or without nipples, or supernumerary nipples (polythelia) without breast structure. The supernumerary nipples and breasts are usually found along the lines corresponding to the bilateral rows of mammæ in the carnivora and many other mammals, extending from the axilla to the groin through the normally situated gland. Aberrant supernumerary mammæ have also been observed in other sites, as on the shoulder, on the back, on the hip or thigh, on the median line, or even on the face. As many as eight breasts have been noted, and a case is reported of a woman having five mammæ which secreted milk. There may be two nipples on the same areola, or two areolæ and nipples.

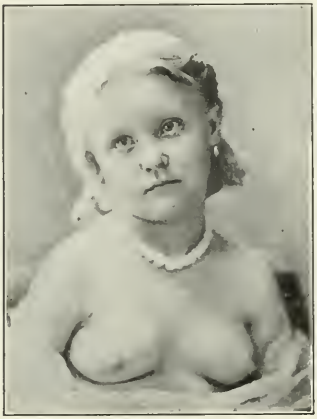

Fig. 377. Precocious Development of Breasts in a Child Four Years and Nine Months Old. Menstruation began at the age of fifteen months. (Original.)

Hypertrophy of the Breast.—Many extraordinary cases of development of the mammary function at the extremes of life, as a consequence of stimulation, are recorded. These may be important in a medico-legal way. Sheild mentions a case in which a woman of sixty-one years suckled an infant granddaughter; also a case, described by Baudelocq, of a girl of eight who suckled a child. There are found in Sheild's tables instances of unusually early development of the breasts and sexual organs (Montgomery); pregnancy at eleven, with great enlargement of the mammæ (Rowlett); menstruation at twelve months; pregnancy at nine years; great development of the mammæ (Embling); full development of mammæ and sexual organs at three years (Dieffenbach); great size of mammæ with menstruation in an infant under two years of age. In a case which came under the cognizance of the writer the child menstruated at fifteen months and the breasts were large and well developed at four years and nine months. (See Fig. 377.) Many cases of abnormal development of the breast in males (gynæcomastia) are recorded; also well authenticated instances of the function of lactation having been performed by a man. True hypertrophy of the breasts, forming large tumors, is rare; most of the cases are reported as having been observed about the time of puberty or before the twentieth year; only a single case being recorded as having occurred after the menopause. It would seem, therefore, that the overgrowth is oftenest incidental to sexual development. Simple hypertrophy is due to hyperplasia of the normal constituents of the gland. In some cases the hyperplasia seems to be general, and to involve not only the glandular, but also the fatty and connective tissues. In by far the greater number of cases, however, the enlargement seems to be due to an abnormal overgrowth of fat and connective tissue, without corresponding increase of the proper gland tissue, which is sometimes even atrophied. Both breasts are usually affected: one-sided hypertrophy being always suggestive of a neoplasm. When the hypertrophy is associated with pregnancy the growth is apt to take place very rapidly. The breast sometimes attains enormous size, hanging down to the pubes or even to the knees: in one recorded instance it weighed as much as thirty pounds, and in another case sixty-four pounds, post mortem. The deformity and weight are sometimes so great as to necessitate removal of the hypertrophied breasts, occasionally even during pregnancy. Before proceeding to operation, however, the surgeon should give due consideration to the possibility of relief by other means. The recumbent position, elevation of the breasts, and pressure should be tried. The patient may be put on a limited diet, and the administration of iodine internally or by friction, and of thyroid extract, should be given a fair trial. Should removal become necessary, it must be borne in mind that the blood supply is often very free and that dangerous hemorrhage may be encountered in the operation.

Wounds of the Breast.—Incised or gunshot wounds of the breast, when carefully treated with aseptic precautions, behave very much like similar wounds elsewhere; a clean incised wound usually healing by first intention.

The mammary tissue heals readily, as may be seen after the removal of benign tumors. The coexistence of lactation may modify the progress of the healing. In the case of a wound received during functional activity of the gland, suckling from it should be suspended. Bruises or wounds made by blunt instruments frequently cause extravasations of blood, subcutaneous or intraglandular. As a rule, the blood is slowly absorbed, but it may become infected and suppuration ensue. Traumatism is sometimes followed by changes in the breast predisposing to the development of malignant growths: but the relative proportion of neoplasms dependent on such injuries is undetermined. Ulceration may destroy the nipple, in which case mastitis is very sure to develop after each subsequent confinement. Scars following burns frequently displace the nipple by their contraction, but do not necessarily give rise to serious disturbance during lactation.

Neuroses of the Breast.—Neuroses of the breast are met with most commonly in young unmarried women. Peculiar sensations in the breast are often experienced at the time menstruation becomes established, and, later, at the beginning of each menstrual period. Similar uneasy sensations often become troublesome at about the time of the menopause, and in neurotic individuals often arouse the fear of a beginning malignant growth. Severe neuralgic pain (mastodynia) may be localized in the breast itself or may shoot through the breast into the shoulder, the arm, or the side. In hysterical subjects the breasts, one or both, often become sensitive and painful, and the skin over the breast may be so hyperæsthetic that even the slight pressure of the clothing becomes unbearable. This condition is often associated with some disturbance of the pelvic organs, which should first of all receive proper attention. It also happens in the intercostal neuralgia which complicates neurasthenia. In certain instances minute, indurated nodules (neuro-fibromata) may be detected in the breast and may be a cause of intense pain. Severe mastodynia may occur also in women suffering with gout or rheumatism. The treatment should be directed, as far as may be, to the removal of the primary cause of the neuralgia, and to the improvement of the general health. In cases associated with neuro-fibromata the little tumors should be removed; in those dependent on gout or rheumatism the treatment should be planned with due reference to this condition. The mental condition and morale of the patient have often much to do with these neuralgic manifestations, and should therefore receive careful attention.

Acute Inflammations of the Breast (Mastitis Acuta).—Inflammation of the breast occurs at all ages, but especially in earliest infancy, at puberty, in connection with lactation, and about the time of the menopause. The following different forms or types may be distinguished: mastitis neonatorum, mastitis adolescentium, mastitis traumatica, and mastitis puerperalis.

Mastitis Neonatorum.—This form of inflammation of the breast appears in the two sexes alike, and oftenest within the first week after birth. The breast becomes swollen, generally with redness of the skin, and, in some cases, with a milky or serous discharge from the nipple. Oftentimes an officious or overzealous nurse makes a mistaken attempt to "rub away the milk," thereby lighting up inflammation or aggravating already existing trouble. The etiology of the affection is still somewhat indefinite, nor is it even certain that the process is always inflammatory. Warren, having found in new-born infants a proliferation of the epithelium with shedding of epithelial cells and accumulation of granular débris within the ducts, believes that something akin to an inflammatory process may be already going on in the breast at birth. Koelliker regards the affection as incidental to the physiological development of the gland; De Sinety attributes the secretion to the degeneration of the epithelium, filling the ducts with débris before birth, and also to an actual secretion of milk.

Rubbing or massage of the breast should be avoided. Hot compresses frequently applied are soothing and effective. Suppuration sometimes occurs, necessitating immediate and free opening of the abscess; the incision should be made in the direction of the lactiferous ducts, which are arranged radially from the nipple as a centre. With adequate provision for drainage, healing takes place rapidly.

Mastitis Adolescentium.—Mastitis occurring about the time of puberty affects the breasts of boys as well as girls. The tensely swollen gland is often very painful, and is hard and elastic to the touch. Circumscribed small nodules may be detected within the breast, or the induration may involve the entire gland, which may be felt as a firm disc. Pressure on the gland, and in some cases movements of the arm, evoke pain. In severe cases the pain is intense, the nipple becomes red and inflamed, the breast greatly enlarged, the axillary lymph nodes often swollen, and in some cases hard strands are felt leading to the nipple. In most cases the inflammation gradually subsides, and in the course of a few weeks the breast becomes normal. Only rarely does suppuration occur, calling for free incision. Moist warm applications and carefully adjusted pressure favor resolution.

In the less severe cases the breast becomes moderately swollen, the nipple prominent, the areola pigmented and sometimes reddened, and there is more or less of dull aching pain. Usually these symptoms disappear in the course of two or three weeks. In young girls a painful swelling of the breast may occur in connection with menstruation, and is due probably to the changes incident to sexual development. Vicarious menstruation, taking the form of hemorrhage from the breast, has also been observed at this period.

Mastitis Traumatica.—Trauma of the breast in men, from direct pressure as in using the bit stock in boring, is frequently followed by inflammation. The mastitis may become chronic, or infection may occur through a scratch or a furuncle, giving rise to suppuration.

Mastitis Puerperalis.—The great majority of cases of acute mastitis occur in nursing women, especially in primiparæ. The inflammation begins most frequently within the first month after delivery, and oftener in the third or fourth week than earlier. It usually begins by attacking only a part of the gland, oftenest the lower and outer part. The most common etiological factor is infection. Scratches and fissures about the nipple serve as the points of entrance for pyogenic germs, but it seems almost certain that in some cases they find their way directly into the milk ducts by way of the nipple. The fact that cases of acute mastitis occur in which the nipple is absolutely healthy supports this belief. Primiparæ, being much more subject to abrasions and excoriations of the nipple than are women who have previously suckled children, are much more exposed to infection through this channel, and consequently suffer much more frequently from acute mastitis during the puerperium. Mastitis may develop as a metastasis following puerperal metritis; also as a direct infection by gonococci transferred from the vagina of the mother or in the discharge from a gonorrhœal ophthalmia in the nursing infant. It seems certain, as taught by Billroth, that in most cases the retention of milk in the affected breast is secondary to the infection, rather than its cause. There is, however, a simple mastitis which occurs toward the end of pregnancy and which appears to be due to stagnation incident to a premature secretion of milk. Similar cases are seen also later in the puerperal period, although most frequently soon after parturition. The breast swells and becomes painful and sensitive to pressure, and the distended lobes may be distinctly palpable. There is some redness of the skin; ordinarily fever is slight.

This simple form of mastitis may be followed by abscess. The stagnation of milk undoubtedly favors bacterial development, and fissures or abrasions of the nipple offer ready avenues of infection. Infection of the sebaceous glands of the areola, or small abscesses developing beneath the areola, may cause extension of the suppurative process in the subcutaneous tissue of the breast, or may involve the parenchyma of the gland itself. Infecting micro-organisms, entering by the nipple, may invade the interior of the gland by way of the milk ducts. The inflammation may extend in so many ways from one tissue to another as to make it impossible, in certain cases, to determine the path of the infection. Suppuration may occur in the tissues in front of the gland (paramastitis), behind the breast (submammary or postmammary abscess), or in the gland substance itself (intraglandular abscess). Submammary abscesses result occasionally from caries of a rib or from a breaking down of tuberculous deposits in the pleura contiguous to the breast; therefore not necessarily in connection with lactation or pregnancy. Such abscesses are slow in developing, comparatively painless, and as a rule small, hard, and well defined. They may be readily mistaken for deeply seated solid tumors, from which they are best distinguished by their fixed relations with the thoracic wall, and, clinically, by the fact that they rarely occur except in women of so-called scrofulous habit. Involvement of the axillary lymph nodes is usually present. In a doubtful case an exploratory operation may be indicated, to clear the diagnosis.

A superficial abscess following acute mastitis generally develops rapidly and without very severe constitutional disturbance. An intraglandular abscess, on the contrary, is attended by manifestations of much greater severity, both local and constitutional. The inflammation may affect one or several of the component lobes of the gland. The dense, rigid, and slowly yielding gland tissue compresses the inflamed structures, giving rise to a feeling of weight, burning heat, pronounced throbbing, and often agonizing pain. The constitutional disturbance is commonly severe. The entire breast may become enormously swollen before the integument shows either redness or swelling. Ultimately, the pus makes its way to the surface.

Submammary abscess develops more slowly and is less painful than intraglandular abscess; the nipple is often but little or not at all implicated, and the extension of the inflammatory process to the integument of the breast is long delayed. There is ordinarily but little constitutional reaction up to the time when the gland itself, the fascia, or the integument becomes involved. It is especially characteristic of submammary abscess that the gland is pushed forward as a result of the accumulation of pus behind it, so that when pressed by the hand, against the thorax, it feels as if resting upon a water bed, or on an air cushion. The course of the pus toward the surface may be either through the gland between its lobes, in which case pointing may occur near the areola in the direction of the sterno-clavicular border where the glandular tissue is thinnest, or the pus may find its way around the gland, to point at perhaps several places near the periphery of the breast.

TREATMENT. In non-suppurative mastitis the treatment should be directed to overcoming the condition of stasis of the milk. The nipples should be carefully examined for any mechanical obstruction to the free flow of milk, and for possible malformation, such as a retracted nipple, which might prevent the emptying of the breast by the infant. Search should also be made for such lesions as eczema, warts, ulcerations, cracks, etc., of the nipple, or fissures or furuncles of the areola. The breasts should be emptied of milk as rapidly and as thoroughly as possible, whether by suckling the infant, by the use of the breast pump, by massage, etc. When the breasts are heavy and pendulous efficient support should be given, either by strapping the breast with strips of zinc oxide adhesive plaster or by the careful application of an elastic bandage. The bandage is passed twice obliquely about the chest, compressing the lower half of the right breast and the upper half of the left breast with one turn, and the upper half of the right breast and the lower half of the left breast on the second turn. This serves the double purpose of suspending the heavy breast and at the same time assuring gentle, equable, and constant pressure. Should hard nodules persist in the gland beyond the period of lactation, the induration may be treated by massage and pressure, by the application of iodine ointment, etc. Eliot has reported good results from the use of turpentine poultices applied over the inflamed areas after they have been bathed with spirits of turpentine. Inasmuch as, in mastitis due to infection, the integrity of the breast is gravely imperilled by destructive suppuration, it is important to open the abscess or abscesses as early as possible, and to make effective provision for free and continuous drainage. Whenever hot fomentations and pressure fail to bring about definite improvement within a few days, and when increasing pain, œdema of the skin, rise of temperature and pulse, with perhaps rigors, make the diagnosis of suppuration practically certain, the surgeon should not wait for fluctuation but should make free incisions into the inflamed areas, bearing always in mind that new foci of suppuration may appear in lobes not previously affected, and that subsequent incisions may be required. Free incision with perfect drainage affords the most effective means of arresting or controlling an inflammatory process in the stage of incipient suppuration; it follows, therefore, that early and free incision of an infected and inflamed breast, saving the patient from preventable grave mutilation, is pre-eminently the conservative procedure. The foci of suppuration are ordinarily small, but the free drainage of the infiltrated tissues both limits the destructive process and enables the inflamed organ to throw off the infection and go on to the stage of repair. Superficial incisions into the outlying portions of the abscess are worse than useless. Not only are they ineffective in controlling the inflammatory process, but they do harm by opening up additional areas to infection. The incisions should radiate from the nipple, to avoid, as far as possible, the cutting of the milk ducts. They should be long enough and deep enough to reach entirely through the infected and indurated tissues, and thus insure free and dependent drainage. Larger abscesses should be freely opened by long radial incisions, which should be numerous enough to insure against possible damming or mechanical retention of liquid in any part of the gland. Whenever suppuration is extensive, with large abscesses, the patient should be anæsthetized, a free incision made into an abscess cavity, a finger introduced, and, as far as may be, the fibrous septa between it and any adjacent cavities broken down. Other incisions, as numerous and extensive as may be indicated, follow, until the entire affected area has been thoroughly explored: the knowledge of the extent and direction of the burrowing channels acquired by the introduction of the finger enabling the surgeon to proceed intelligently in making such supplementary incisions as may be necessary.

The infiltrated, sloughing gland tissue may be curetted, and any remaining shreds or masses removed with the scissors or forceps. The wound is then packed and thickly covered with sterile or antiseptic gauze, and a bandage applied with moderate pressure. The writer attaches little importance to irrigation of the infected cavity, and prefers a loose packing of sterile gauze to the iodoform gauze recommended by many surgeons. When the work has been thoroughly done the process of repair advances rapidly and in a satisfactory manner; the gland tissue is at least in part conserved, and the ensuing cicatricial contraction minimized. On the other hand, a temporizing course, or reliance on small incisions, however numerous, is ordinarily followed by very slow healing, with general atrophy of the gland and formation of much scar tissue—a condition which, as is generally recognized, is apt to lead to the subsequent development of carcinoma.

In submammary abscess, in which the breast is lifted from the underlying muscles by pus accumulating in the subjacent loose tissue, a bold incision should be made along the lower margin of the gland, and drains should be so placed as to maintain free evacuation. As the discharge diminishes the drains may gradually be withdrawn. In a few cases the suppurative process may become so extensive and inveterate as to necessitate amputation of the entire breast.

Some patients will decline to submit to surgical treatment of mastitis, especially in the early stages of the inflammation. In cases of this character, in which radical treatment is out of the question, the application of cold, by means of ice bags to the inflamed breast, may be at least palliative.

Artificially induced hyperæmia (*Stauungshyperæmie*), which is commonly produced by the application of a large bell-shaped cupping-glass (with exhaustion of the contained air) over the inflamed breast, is highly extolled by Bier as a principal remedial agent in all forms and stages of mastitis, and as an important adjuvant to incision of deep foci of suppuration. In the earlier stages of the disease an effort is made to draw out the confined secretions through the nipple, and later to draw out also the pus from any fistulous openings and from relatively small operative incisions. It is claimed that by this method the treatment is notably shortened, and that, even in aggravated cases, much of the glandular tissue is conserved.

Kaarsberg has strongly recommended massage of the breast in mastitis; he claims that thereby both the accumulated milk and the pus may be removed from the breast. The manipulation necessary to effect this result is so painful as often to necessitate the employment of a general anaesthetic; and the instructions state that the procedure should be continued for half an hour at a time, and repeated at least twice a day for several succeeding days. The method of Bier is much less severe, as well as more efficacious.

In mastitis due to bacterial infection the child should not be allowed to nurse, even though the pain be not intolerable, as it ordinarily is. The breast should be emptied artificially by means of the breast pump or by massage, and the secretion of milk held in check by saline purgatives. Neglect or inefficient treatment exposes the patient to increased risk of general infection.

Chronic Inflammations of the Breast (Mastitis Chronica).—Particular forms of chronic inflammation of the breast have been described under different names: as, for example, chronic cystic mastitis (Koenig), interstitial mastitis (Virchow), cystic disease of the breast (Reclus), cystadenoma of the breast (Schimmelbusch) chronic mammary tumor (Astley Cooper), etc. The conditions noted by certain writers correspond so closely to the atrophic changes incident to old age as to suggest the possibility that in some cases senile conditions may have been interpreted as pathological. It is certain, however, that there are cases of chronic interstitial inflammation of the mamma which eventually develop special pathological conditions, due to hyperplasia with contraction of the fibrous tissue. The newly formed connective tissue, in contracting, compresses the secreting acini and the ducts, with resultant atrophy and disappearance of the gland tissue; the entire breast, or the affected portion, becomes converted finally into a contracted mass simulating dense scar tissue. In a large, heavy, pendulous breast, the transformed gland may feel like a ball under the skin; in a smaller breast it may be lifted from the underlying tissues and feels like a quoit just beneath the surface.

It is often difficult to distinguish pathologically between chronic mastitis and senile fibroid transformation. When only portions of the breast are involved, it may be extremely difficult to differentiate the affection from fibro-adenoma, or from cancer. In chronic mastitis the fibrous tissue encloses and surrounds the interstitial fat of the breast, whereas fibro-adenoma, a benign growth, pushes aside the fat and other constituent parts of the mamma. In most cases of chronic mastitis there is cyst formation with proliferation of the epithelium of the acini; these becoming choked with cells which break down to form central cavities. Some writers regard the epithelial proliferation as secondary to the contraction of the newly formed connective tissue, the effect of which process is to compress and occlude the ducts. Koenig believes that the duct system is first affected; Schimmelbusch, on the other hand, ascribes the origin of the cysts to an overgrowth of the epithelium of the acini.

Although in most cases of chronic interstitial mastitis the disease is observed about the time of the menopause, it may appear at any time after puberty. In young women it occurs oftenest in neurotic subjects, and is generally associated with some disturbance of the pelvic organs, frequently with disorders of menstruation. In married women it seems to occur most frequently in those who are sterile or in those who, having borne children, have not suckled them. Pain is usually a prominent feature and is commonly severe; in neurotic individuals it may even be agonizing. Simply touching the affected breast causes great pain, and many shrink even from the thought of having the breast touched. If pressure is made over the point where the mammary gland filaments of the intercostal nerves make their exit from the thoracic wall, great pain is elicited. The axillary lymph nodes are not enlarged or indurated. There is no fever. Sometimes both breasts are affected. In cases of diffuse interstitial mastitis, the disease advances slowly, and ends in contraction of the newly formed fibrous tissue.

There is a form of mastitis which occasionally develops about the time of the menopause, pursues a chronic course, and gives rise to circumscribed, firm induration with marked shrinking of the breast and retraction of the nipple and skin. In this form of "scirrhous" mamma, the axillary lymph nodes are usually enlarged. Such cases are rare, but are important as being difficult to distinguish from certain types of carcinoma. According to Warren, who reports a case in a young woman, the disease may occur early as well as late in life. It is well to remember that in chronic interstitial mastitis the mass does not increase progressively in size, whereas such increase is the rule in neoplasms.

Clinically, the distinction between a carcinomatous mass, a fibro-adenoma, and a chronic mastitis can usually be made, but it may be a very difficult thing to do. The method of examining the breast by pressing it between the flat of the hand and the thoracic wall will give information of great value. The examiner stands behind the patient and, reaching over the shoulder, presses the breast against the thorax with the flat hand; if no circumscribed tumor is felt, the diagnosis of a cyst, a fibro-adenoma, a carcinoma, or other neoplasm, is excluded. If the breast is examined by pressing it between the thumb and fingers, a chronically indurated area may give much the same sensation as does a tumor, but, if it is examined with the flat hand pressing against the chest, the resemblance to a neoplasm disappears.

Treatment.—The internal administration of potassium iodide or other form of iodine, conjoined with the application of mercurial ointment or of compound iodine ointment, with support of the breast in such a manner as to exert equable and constant pressure, if it can be borne, and with attention to the general health, may lead to resolution of the tumor. Should this fail to bring relief, amputation of the breast may be necessary, as the pain is not infrequently so severe as to compel this sacrifice. Furthermore, the danger of persistent irritation, possibly eventuating in the development of carcinoma, and the fact that it is sometimes impossible to make a positive diagnosis as between chronic mastitis and contracting scirrhous cancer, must be borne in mind as reasons for operating in certain cases. When one is in doubt, it is best to err on the side of safety and remove the gland.

Galactocele.—Galactocele is a cystic formation containing milk or its derivatives. It is a comparatively rare affection, originating in dilatation of the galactiferous tubes, with rupture of their walls and escape of milk into the cellular connective tissue, as a result of which the latter becomes so condensed as to form a sort of cyst wall. The contents of the cyst vary very much. At one time they consist of a turbid fluid with admixture of colostrum corpuscles, at another they consist apparently of pure milk, of a substance resembling butter, of a liquid resembling cream, or of cheesy masses. The cyst is usually single, and seldom attains a size greater than that of an egg or an orange. Exceptionally, however, it reaches an enormous size; one having been described by Scarpa which contained ten pounds of fluid. An old galactocele, with inspissated contents, may become very hard, and may easily be mistaken for a neoplasm. In very rare instances the wall of the cyst becomes calcareous. The diagnosis turns largely on the clinical history—the development of the tumor in connection with pregnancy and lactation, its tendency to undergo enlargement during lactation or suckling, etc. It may be impossible to reach a positive diagnosis except by aspiration or incision.

Treatment.—The treatment is operative, but interference should, if possible, be postponed until the secretion of milk has practically ceased. In very recent cases aspiration of the cyst will sometimes effect a cure; in others, incision with drainage or packing is necessary. In cases of old galactocele, with thickened and indurated walls, it is generally best to dissect out the entire cyst. In indurated galactocele, Keen recommends amputation of the breast; and, in general, when the cyst is old and thick-walled, or when the cyst walls are calcareous, as in a case observed by the writer, or, finally, when there are multiple cysts, this is unquestionably the proper course. (Fig. 378.)

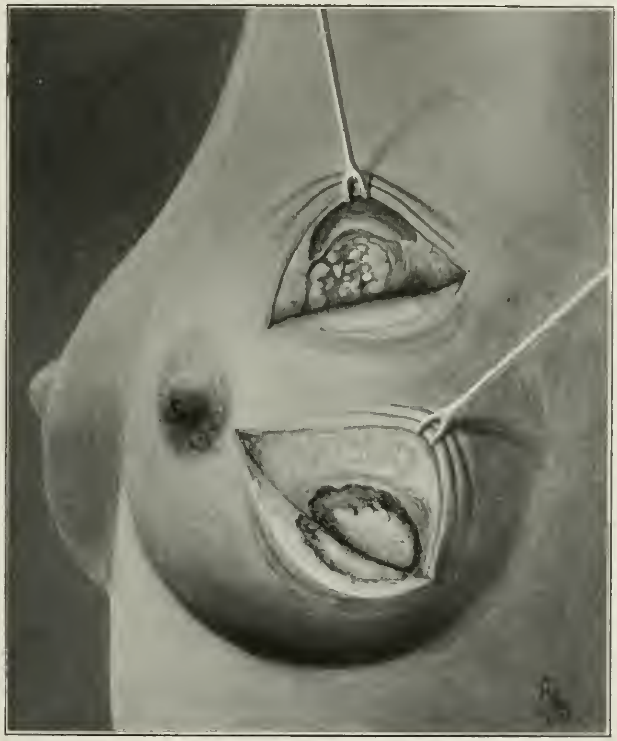

Fig. 378.—Multiple Galactocele. (Original.)

Tuberculosis of the Breast.—Tuberculosis of the mammary gland, although not common, is not so rare as has been supposed. Writing in 1898, Levings found only fifty-seven reported cases, but saw seven cases himself within two years. It seems certain that the condition often goes unrecognized. Tuberculous disease of the breast occurs most frequently in women of middle age. A case reported in *Schmidt's Jahrbuch* (1891), in an infant of one year, and another recorded case, in a woman of fifty-three years, are exceptional. The disease is said by most authors to be oftenest secondary, as when the mamma is attacked by extension from some neighboring organ, such as the axillary lymph nodes, the ribs, or the pleura. There can be little doubt that the process is more frequently primary in the breast than has heretofore been recognized. Of five cases of mammary tuberculosis observed by Kamamura (1904), four were classed as primary. Clinically, tuberculosis of the breast may show itself under different aspects; most frequently perhaps in the form of deep isolated nodules which later become fused into a single nodular mass. The course of the disease is typically chronic; the hard, irregular tuberculous mass or masses persisting often for months or years before breaking down occurs. Velpeau has described cases in which multiple isolated masses had undergone central caseous degeneration. The breast is, as a rule, but slightly, if at all, enlarged. Fairly circumscribed, nodular areas of induration can be felt on palpation. These nodular masses tend slowly to increase in size, and later to break down by suppuration and open externally; the breast becoming riddled with sinuses. Usually there is retraction of the nipple, but the breast remains freely movable on the subjacent tissues. The axillary lymph nodes are often swollen or in a state of caseous degeneration. Both breasts may be implicated. Circumscribed cold abscesses may form within the gland; the breast increasing gradually in size and becoming tense and fluctuating. In rare instances the abscess is outlined by a ring of dense, infiltrated breast tissue. The skin over the abscess remains normal. Incision is followed by escape of thin, curdy pus; and the cavity is found lined with a characteristic membrane. (Halsted.)

Tuberculous infection is supposed to take place by way of the lymphatics. Halsted believes that in most cases there is a retrograde transmission through the lymphatics from tuberculous disease in the axilla or in the thoracic cavity. Infection may also occur through the milk ducts, or from a surface wound such as a fissure of the nipple or an abrasion of the breast. In such cases the bacilli may be introduced, through nursing, from the mouth of a tuberculous subject. Functional activity of the breast undoubtedly predisposes to the infection.

Diagnosis.—In the early stages of tuberculosis of the breast the diagnosis is always difficult, and may be impossible even in more advanced cases, except with the aid of a microscopic examination. When sinuses have formed, the general appearance of the sinus and the character of the discharge are distinctive. Microscopic examination, cultures of the breast secretion or of bits of the diseased tissue, and inoculation of animals, may confirm the diagnosis. In primary tuberculosis of the mamma tubercle bacilli are by no means always found. Schley states that in seventy-seven cases Gautier found typical bacilli only twenty-nine times, and that Scudder found bacilli only twenty-nine times in eighty cases. When the disease is primary in the breast, and is limited to the gland and the axillary lymph nodes, the prognosis is favorable. If the disease is widely disseminated, and other organs are implicated, the prognosis will turn on the extent of the disease and the parts involved.

A child should never be allowed to nurse from a breast affected with tuberculosis, lest it become infected from this source.

Treatment.—In cold abscesses, incision, or removal of the abscess wall, and treatment of the wound with iodoform may be tried; but the wisdom of such procedures is questionable. Amputation of the breast, with complete cleaning out of the axilla, is the better course. A tuberculous mass left in the gland is very likely to give rise to infection of the axillary lymphatics, and infection may also extend to the lung, liver, or mediastinal lymph nodes. Tuberculous foci are often found in supposedly healthy lymph nodes at a distance from the original disease. In secondary tuberculosis of the breast, the diseased mass should be removed whenever the disease is not too far advanced elsewhere and when the general condition of the patient warrants such interference. The general health of the patient should always receive careful attention.

Syphilis of the Breast.—Syphilis may manifest itself in the breast either as a typical gumma or as a diffuse disseminated process. At first, the induration of a gumma may be poorly defined, and there may be entire absence of sensitiveness; later, the affected area becomes circumscribed and there is tenderness on pressure. In its early stages, it may be difficult or impossible to distinguish between a gumma and a neoplasm. The axillary lymph nodes are commonly enlarged. The nipple may be retracted if the mass has its origin in the centre of the breast. At a later stage the gumma may become adherent to the skin, and may ulcerate, or it may slough away in its entirety. Gumma of the mamma proper is very rare. Occasionally one sees a tertiary or late secondary syphilitic affection of the breast in which there is a more or less uniform, indurated enlargement, generally smooth, and not very sensitive. Such a syphilitic mastitis may affect one or both breasts. Usually other evidences of syphilis may be found. This form of late syphilis, as also gumma of the breast, ordinarily yields to the intelligent administration of potassium or sodium iodide, either alone or in combination with mercury. There has also been noted, in connection with hereditary syphilis, a mastitis in which atrophy of the gland generally supervenes.

Actinomycosis.—A few cases of this very rare affection of the breast have been reported. The disease may be primary in the breast, or secondary to actinomycosis of contiguous parts. In most cases the disease affects first the lung, the pleura, or the thoracic wall, and extends to the breast by continuity. Cases have been recorded in patients of ages ranging from twenty-two to thirty-five years. When primary in the mamma, it is at first painless, and is ordinarily discovered by chance. It appears in the form of one or more hard nodules or masses, usually well defined, and not adherent to the neighboring tissues. The general health is not affected, and the axillary lymph nodes are not involved. The latter sign is important in diagnosis, as differentiating actinomycosis from carcinoma and tuberculosis, in both of which diseases involvement of the axillary lymph nodes is ordinarily present.

If the disease has advanced to the stage of suppuration, or if the actinomycotic masses have been removed, microscopic examination of the pus or of the tissues should establish the diagnosis. With a definite diagnosis of actinomycosis, the treatment should be the immediate amputation of the entire breast and, if the disease involves contiguous tissues, the cutting or curetting away of the affected parts as completely as possible. The surgical treatment should be reenforced by the administration of potassium iodide in large and increasing doses.

III. TUMORS OF THE FEMALE BREAST.

Tumors of the breast represent almost every known type; hence their accurate discrimination is of vital importance from the prognostic as well as the therapeutic point of view. Descriptions of pathological findings are, however, so varied, and so many names have been employed to emphasize more or less essential differences, that the surgeon is apt to be confused in his attempts at a satisfactory classification. To avoid confusion and at the same time to lay proper stress on essentials, the simplest possible classification is to be preferred. The tumors of the breast will, therefore, be considered here largely from the clinical standpoint, and, primarily, under the two heads of benign and malignant growths. Even this distinction is, however, imperfect, inasmuch as some tumors which, early in their development, are distinctly benign, may later undergo malignant transformation, while in other cases it may be difficult or impossible to draw a definite line. Hence even the distinction between benign and malignant neoplasms must of necessity be relative, and must often turn on clinical characteristics even more than on pathological considerations based on differences in structure.

Structurally, the benign tumors, as contrasted with the malignant growths, are, generally speaking, homologous; that is, they are made up of tissues resembling the normal constituent tissues of the breast. The benign group includes, of the connective-tissue tumors, the fibromata in their various forms; and, of the epithelial tumors, the simple and mixed adenomata. In the malignant group we find, of the connective-tissue tumors, the various sarcomata; and, of the epithelial tumors, all the types of carcinoma. To this general division, however, there are marked exceptions; the enchondromata, for instance, are structurally heterologous, although clinically benign.

Classification.—For clinical purposes, tumors of the breast may be classed as:—

1. Tumors springing from and closely resembling fully formed tissues of the connective-tissue group—fibro-adenoma, myxoma, lipoma, also chondroma,—all of which are clinically benign.

2. Tumors derived from the connective tissue and resembling it in its embryonic or transitional stages,—sarcoma in its different forms,—but all of them malignant.

3. Tumors derived from the glandular epithelium, and more or less closely resembling glandular tissue. This class includes pure adenoma, adeno-fibroma (adenoma with admixture of fibrous tissue), and adeno-cystoma (adenoma with cysts); all of them benign. But growths combining glandular tissue with

atypical connective-tissue elements (round cells, spindle cells, or giant cells)—adeno-sarcoma—belong to the clinically malignant group.

4. Tumors composed of atypical epithelial cells—carcinoma;—also tumors combining glandular tissue with atypical epithelial cells—adeno-carcinoma. These tumors are typically malignant.

5. Tumors resulting from a new growth of certain special tissues, as nerves and blood-vessels—neuromata, angiomata, etc.—all of them benign.

Tumors of the breast are subject to numerous and varied forms of degeneration, giving rise to conditions which have been described as sub-varieties, with resultant confusing multiplication of names. Thus a sarcoma or a fibro-adenoma may undergo a myxomatous change or may become cystic, or a sarcoma may develop cartilaginous or bony areas, etc., the tumor remaining, however, distinctively a sarcoma, or a fibro-adenoma;—an all-important distinction which determines the malignant or benign character of the growth. Embarrassment in diagnosis may result also from changes in the breast incident to the period of life or to the state of physiological rest or activity; or, again, characteristic features may be obscured by changes in the component tissues of the breast resulting from recent or old inflammatory complications. To minimize possible confusion, the study of tumors of the breast should be directed rather to the clinical picture as a whole than to particular conditions considered more or less apart from the whole. Familiarity with the general characteristics of the principal types of mammary tumors—fibro-adenoma, sarcoma, and carcinoma—will go far toward resolving doubt in individual cases.

General Characteristics.—Benign tumors are made up, in a general way, of tissues which more or less closely resemble the normal tissues of the breast. They are as a rule definitely circumscribed, sharply outlined, and movable within the breast. As they increase in size they displace but do not invade the contiguous tissues. Carcinoma, on the other hand, infiltrates and destroys the neighboring tissues, is without definite demarcation, and is immovable apart from the breast as a whole. The malignant tumors are ordinarily of more rapid growth than the benign, the rapidity of increase being generally related to the proportion of cellular elements in the growth. As a rule, the softer and more vascular tumors are those most likely to give rise to metastases, therefore clinically the most malignant.

Metastases are an indication of malignancy; they occur early in the soft, fast-growing tumors, minute portions or clusters of cells being detached and carried away by the lymphatics (in carcinoma) or by the veins (in sarcoma). Cachexia and general exhaustion often accompany malignant tumors, although in most cases only in the advanced stages of the local disease.

The histological differentiation of mammary tumors is often very difficult; the finer microsopic distinctions bearing a somewhat inconstant relation to the clinical picture. The all-important practical question is whether a tumor is benign or malignant; for upon this point must rest the decision as between imperative immediate removal of the growth and permissible delay. In typical cases the clinical diagnosis is generally easy, but there are many cases in which, especially in the early stages of the growth, a positive diagnosis is impossible. In general, the earlier an operation is performed the greater is the probability of a permanent cure; hence in a doubtful case the growth should be promptly removed, and immediately examined. Should the tumor be found to be benign, the operation need be carried no further; but, if it appears to be structurally malignant, the operation must be resumed and the extirpation made radical.

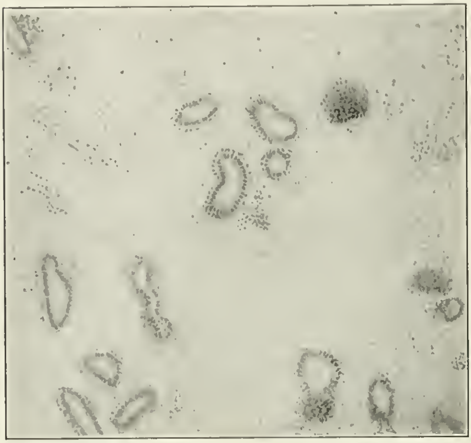

Fig. 379.—Section of Fibro-Adenoma of the Female Breast. Magnified about 150 diameters. (Original.) Note the great predominance of fibrous over glandular tissue.

Fibro - Adenoma.—Fibro-adenoma originates from the glandular and connective tissues of the breast. Pure fibroma and pure adenoma are both very rare. The mixed neoplasm, fibro-adenoma (Fig. 379), is the type of benign mammary tumor most frequently met with. Besides their essential benignity, these tumors are further characterized by the fact that they commonly occur during the period of life when the breast is functionally active. At the one extreme of this group is the hard fibroma; at the other extreme is the much softer and more succulent adenoma composed in great part of glandular tissue. (Fig. 380.) Between these two extremes occur tumors of all intermediate degrees of hardness, according as the fibrous connective tissue or the glandular tissue predominates.

Structurally assimilated to the normal breast tissue, which is characterized by an admixture of true glandular tissue with a varying proportion of dense

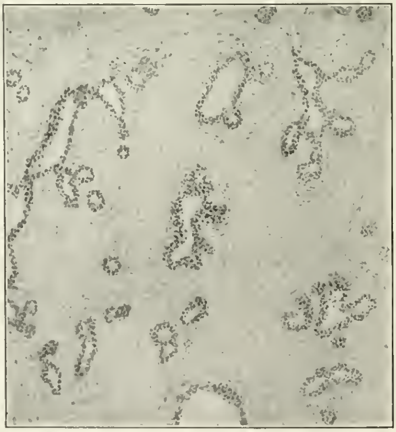

Fig. 380. Section of a Racemose Adenoma of the Female Breast. Magnified about 150 diameters. (Original.)

connective tissue, these tumors may be designated as "adeno-fibroma," or "fibro-adenoma," as the one or the other of the component tissues may be most in evidence. The arrangement of the elements may, however, show wide variation in different portions of the same tumor; one part being perhaps distinctively adenomatous, and another part as distinctively fibromatous. The ducts, also, may become stretched and elongated, with dilatation of the acini, giving rise to the characteristic "cystic clefts" of Schimmelbusch.

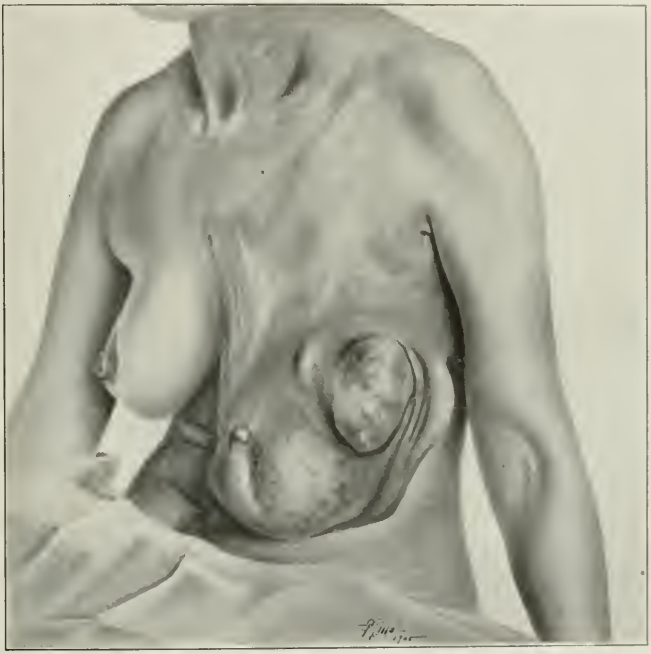

Fig. 381.—Fibro-Adenoma of the Left Breast, Presenting a Close Resemblance to Sarcoma. (Original.)

In fibro-adenoma of slow growth the connective tissue develops as a firm fibrous mass, whereas in tumors of more rapid growth the connective tissue is of a looser, sometimes myxomatous, texture. Thus certain tumors described as "cysto-sarcoma," "intracanalicular myxoma," "adeno-cystoma," etc., are essentially fibro-adenomata presenting individual variation from the ordinary type, determined perhaps by some structural peculiarity pre-existent in the breast.

The firm fibro-adenomata occur for the most part in young girls or in young women who have never been pregnant. Structurally, they consist of masses of connective tissue enclosing portions of normal or altered glandular tissue, with linear spaces lined with normal or with more or less degenerated epithelium. They are, therefore, glandular tumors with exaggerated proliferation of connective tissue. Clinically they are slow-growing, hard, freely movable, circumscribed, usually painless tumors. Adeno-fibromata (Fig. 381) originating at a later period of life, in more fully developed breasts in which more acini are present, are apt to form larger and softer tumors (Fig. 382), more prone to degeneration (fatty or mucous change of the epithelium, myxomatous change in the interacinous connective tissue resulting in cystic degeneration, etc.). These softer and more rapidly growing tumors occur oftenest about the age of thirty to thirty-five. To the adeno-fibromata belong tumors described as "circumcanalicular," "intercanalicular," and "intracanalicular" or "cystic" fibromata (Fig. 383), the latter constituting a large proportion of all the cystic tumors of the breast.

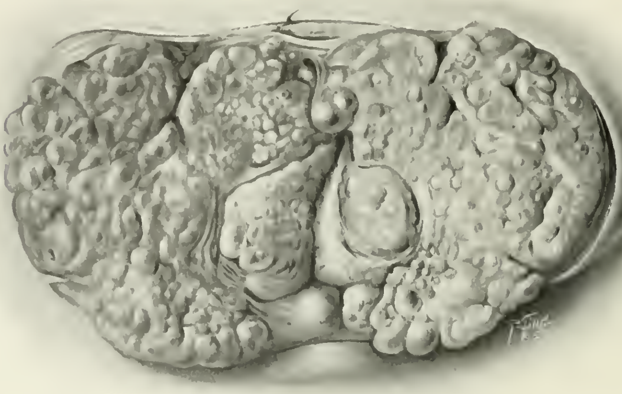

FIG. 382.—Section of the Fibro-Adenoma Shown in Fig. 381. Natural size. (Original.)

A peculiar form of chronic mammary tumor has been described by Reclus as "maladie cystique"; also by Schimmelbusch, who has described a similar affection to which he has given the name of "cystadenoma" of the breast. Both authors have observed a tendency in these growths to carcinomatous degeneration. In a series of cases reported by B. Farquhar Curtis—the pathological findings by F. C. Wood—the conditions correspond closely to those described by Reclus and Schimmelbusch; namely, chronic induration with some enlargement of the whole or a part of the breast, occurring usually in women of middle age—sometimes between twenty and thirty, but much more frequently between thirty and forty. This condition may persist after the menopause, although rarely beginning so late in life. Curtis describes two pathological varieties: the one characterized as a form of chronic interstitial mastitis, the other described as "diffuse fibro-adenoma." Typical cases may readily be referred to one or the other of these two classes, but in other cases such a differentiation is impossible; occasionally the two conditions are found in different parts of the same breast. The diffuse fibro-adenoma of Curtis is described by Schimmelbusch as a fibrous-tissue growth containing numerous cysts with thick gelatiniform contents; a tumor in which an abundant hyperplasia of the epithelium of the acini precedes the cyst formation. In most cases the growth has no defined boundary; hence the name "diffuse" fibro-adenoma. An abundant round-cell infiltration of the connective tissue, a less marked adenomatous development, and the presence of numerous cysts characterize the cases of chronic interstitial mastitis. The anatomical changes vary extremely, the distinction between the two classes of cases turning on the relative amounts of glandular and connective tissue. Structurally, these "diffuse fibro-adenomata" differ materially from typical fibro-adenomata. Clinically they differ also quite as materially, in that true fibro-adenomata rarely become carcinomatous, whereas the diffuse fibro-adenomata not infrequently undergo this transformation. A case under personal observation has been carefully studied by Clopton, who was able to follow the transition from a benign to a malignant growth. The case was under observation for about ten years, during which period the tumor, in the beginning clinically benign and microscopically a diffuse chronic cystic mastitis or diffuse fibro-adenoma, reappeared as a clinically malignant and microscopically carcinomatous growth. In places the cells were arranged as in adeno-carcinoma; the general picture being typical of scirrhous cancer, but showing, in some parts, the cystic character of the parent growth.

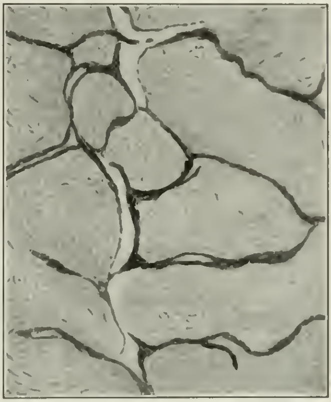

Fig. 383.—Section of an Intracanalicular Fibro-Adenoma of the Female Breast. Magnified about 100 diameters. (Original.)

Prognosis.—The hard, movable, encapsulated fibro-adenoma when once removed does not return. Bearing in mind, however, that at the time of such removal other similar tumors may be already growing, although not yet discovered, the surgeon should give a guarded prognosis. Again, the distinction between some of these tumors and sarcoma is by no means clear. In the case of growths showing cystic and myxomatous changes, suspicion of malignancy is justifiable; moreover, it is a clinical fact that tumors of the breast which contain cysts and intracystic growths are much more prone to recur than are the simple hard fibro-adenomata. The possibility of overlooking incipient carcinomatous changes in certain tumors must also be kept in mind as a further reason for exercising extreme caution in giving a prognosis as to what may be expected to happen after the removal of the growth.

Treatment.—The treatment of all the foregoing tumors is by operation. In the hard fibro-adenoma which occurs in young girls, circumstances may justify delay in its removal, so long as the tumor is small and causes no considerable inconvenience. If the tumor is increasing in size, or if marriage is contemplated, it should certainly be removed. Under the stimulus of pregnancy and lactation the tumor is likely to take on rapid increase, and, almost certainly, to become painful. If the tumor lies near the surface it may be held prominently forward between the finger and thumb, and a radial incision, made directly upon the tumor, may suffice to allow it to be shelled out from its capsule; but it is not infrequently the case that a fibro-adenoma is found to be connected with the gland by a process of mammary tissue, necessitating a careful dissection. Hæmostasis should be perfect before closure of the incision, and care should be taken to bring the breast tissues together in such a way as to avoid dead spaces. Especial precautions should be taken against infection, lest burrowing abscess, giving rise to a disfiguring scar and possible deformity of the breast, ensue. When the tumor is deeply seated, and especially when there is more than one such tumor, removal may be effected by the method of Dr. T. Gaillard Thomas.*

The larger and softer tumors, that occur in older women and are frequently associated with cystic or myxomatous changes, may require amputation of the breast. This also may be done by placing the incision in the manner described by Thomas, the amputation being made subcutaneously and the nipple being left in place.

Cysts.—All varieties of breast tumors may be the seat of cystic transformation incidental to the growth of the neoplasm. The serious import in these cases lies, not in the cyst, but in the character of the tumor; and the treatment resolves itself into dealing with the morbid growth in the substance of which the cysts have been developed. This seems obvious, but may be difficult in practice; the cysts sometimes attaining such a size as practically to obscure the remainder of the original tumor or, in some cases, developing a papillary growth from their walls which may so fill the cavity as to simulate a solid tumor. The differentiation between true cysts and cavities originating in the breaking down of solid growths may also be extremely difficult, and confusion may be almost unavoidable if one trusts wholly to naked-eye examination. Hence the great difficulty of deciding whether a mammary cyst has arisen *de novo*, or has been developed in connection with a pre-existent morbid growth in which it may still be embedded and from which sprouting may have taken place into its cavity. Cysts developed independently of pre-existent neoplasms may be broadly distinguished as retention cysts (galactocele), cysts appearing in the course of simple chronic mastitis, and the rare cases of echinococcus cyst.

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* "On the Removal of Benign Tumors of the Mamma without Mutilation of the Organ," by T. G. Thomas, M.D., in the New York Medical Journal, 1882, xxxv. " . . . The patient standing erect and the mamma being completely exposed, a semicircular line is drawn with pen and ink exactly in the fold which is created by the fall of the organ upon the thorax. This line encircles the lower half of the breast at its junction with the trunk. As soon as it has dried, the patient is anæsthetized, and with the bistoury the skin and areolar tissue are cut through, the knife exactly following the ink line above mentioned until the thoracic muscles are reached. From these the mamma is now dissected away until the line of dissection represents the chord of an arc extending from extremity to extremity of the semicircular incision. The lower half of the mamma, which is now turned off, is, after ligation of all bleeding vessels, turned upward by an assistant and laid upon the chest-walls just below the clavicle. An incision is then made upon the tumor from underneath by the bistoury, a pair of short vulsellar forceps firmly fixed into it, and, while traction is made by these, its connections are snipped by scissors, the body of the tumor being closely adhered to in this process, and the growth is removed. All hemorrhage is then checked, and the breast is put back into its original position. . . . A glass tube, with small holes at its upper extremity and along its sides, about three inches in length and of about the size of a No. 10 urethral sound, is then passed between the lips of the incision, and its lower extremity is fixed to the thoracic walls by India-rubber adhesive plaster and the wound closed by interrupted sutures. . . . On the ninth day the sutures are removed. . . . No depression follows the operation."

Simple cysts in the breast occur most frequently about the time of life when cancer may be expected to develop. They occur in all parts of the breast, and do not show decided predilection for any particular region. Ordinarily there is no retraction of the nipple and no dimpling of the skin, although both of these conditions have been occasionally noted. Cysts may be single, though oftenest multiple; individual cysts varying from the size of a pea to that of an egg, or even attaining much larger dimensions. In some cases there is a clear yellowish, sometimes bloody discharge from the nipple.

DIAGNOSIS.—The diagnosis is sometimes easy, oftener difficult. Variations in size and in the degree of tenderness on pressure are said to be indications pointing to the diagnosis of a cyst. On palpation a cyst often gives the impression of elasticity, or even of fluctuation.

Treatment.—Some authors recommend aspiration of cysts, and report cures effected in this way. Some also inject cysts, after evacuation of their contents, with the object of obliterating the cavity. In view of the demonstration of the possible transition of certain cystic conditions into carcinoma, such practices seem dangerous. Many cysts present small papillary ingrowths, in which a carcinomatous invasion not infrequently takes place. In a case reported by Curtis, a mammary cyst containing about three ounces of fluid showed a perfectly smooth wall, and the surrounding tissues felt soft and normal; yet microscopical examination of a portion of the cyst wall revealed carcinoma.

The safer procedure, in apparently simple cysts, is to excise at least the entire cyst. But many cysts are accompanied by small hard tumors, and, so long as there is no absolutely trustworthy sign by which one may distinguish between such conditions and carcinoma, it is not permissible to wait for the cardinal symptoms of malignancy, such as involvement of the lymphatics, retraction of the nipple, adhesions to the skin, etc., to develop. Moreover, cystic tumors in the breast occasionally show retraction of the nipple or adhesion of the skin to the surface of the tumor, thus simulating malignant disease. Error in differential diagnosis is, therefore, often unavoidable. Hence, in deciding on and in planning any operative procedure, it is best to err, if at all, on the side of safety. It must be borne in mind also that a malignant focus in a lymph node may form such a very small object in the breast as to escape the most careful search by the pathologist.

In dealing, therefore, with a small, single cyst, it is always safest to cut out the wall of the cyst and, in addition, enough of the apparently healthy breast tissue to insure the probable removal of all diseased portions. In the case of very large or multiple cysts, amputation of the entire breast is generally indicated. This may often be done by the method of Thomas. (See page 526.) The tendency of cystic disease to reappear in any portion of the gland that may have been left after operation, should be considered as a valid reason for removing the entire breast in most cases. The mutilation may often be concealed in a measure by not removing the nipple. Finally, the specimen should be subjected to a microscopic examination in order to ascertain whether or not the disease is likely to extend beyond its apparent limits.

Echinococcus Cyst.—Echinococcus (hydatid) cyst in the breast is exceedingly rare, only a very small number of cases having been recorded. The cyst grows very slowly, is painless, and seldom attains any great size.

The fluid contained in these cysts differs from that found in other cysts of the mamma in being non-albuminous and often containing hooklets, which are pathognomonic. Aspiration of the cyst and a chemical and microscopic examination of the contents afford the most trustworthy data for a diagnosis, but in only about half the cases are the characteristic hooklets discoverable even after the most careful search with the microscope. Complete excision of the sac is the only effective treatment.

Lipoma.—Lipoma of the breast itself is extremely rare. Lipomata developing in the retromammary tissue, or in the subcutaneous tissues about the breast, are comparatively common.

A lipoma may displace the gland and possibly give rise to a mistake in diagnosis. Velpeau mentions an instance in which a subcutaneous fatty tumor was mistaken for a mammary cyst; and Billroth has reported a case in which a huge retromammary lipoma, over which the apparently healthy breast was flattened, was mistaken for a hypertrophy of the organ, and accordingly the breast was amputated. Correct diagnosis in such cases is of great importance in planning an operation. When the affection is unilateral it should lead one to suspect a tumor rather than a hypertrophy. In some women the breasts become converted about the time of the menopause into enormous masses of fatty tissue. This should not be classed, however, as lipoma, being in no sense a true tumor. Diffuse lipoma may occasionally affect the pectoral region. The treatment of lipoma is extirpation of the growth; it is seldom necessary to remove the whole breast. After the removal of the tumor, the breast, with the nipple, may be replaced.

Angioma.—Nævus may affect the skin of the breast, but oftener extends also into the subjacent tissue. True angioma of the mamma is very rare. A few cases have been recorded, the tumor sometimes attaining a large size.

The treatment is surgical; in rare cases, strangulation of the growth by ligature is practicable, but as a general rule excision is to be preferred. In removing an angioma the cavernous mass should on no account be cut into; the incisions should be kept well away from the growth, in the healthy tissue, and a competent assistant should be at hand, prepared to catch, on the instant, any vessels that may chance to be divided. The hemorrhage resulting from any operation that involved cutting of the tumor itself would undoubtedly be fraught with grave danger.

In cases of venous angioma (cavernous naevus) and arterial angioma (cirsoid aneurism) Wyeth has practised the injection of boiling water into the body of the growth. The quantity injected may be only a few drops at a time or as much as an ounce or even more, according to the size and location of the tumor; and the injection should be repeated, or not, according to the indications. The result of the procedure has been to consolidate the growth at the site of the injection, and this consolidation has been followed by absorption without subsequent deformity. The water must be injected at the boiling temperature.

In naevus of the skin multiple punctate cauterization, effected by pricking the part with a red-hot needle or by galvano-cautery, may accomplish a cure.

Neuroma.—It would seem that true neuroma never occurs in the breast. Certain so-called neuromata of the breast are of the same nature as the small painful tumors often found under the skin of the extremities, although rarely in the mammary region. These are not true neuromata, but are composed almost entirely of fibrous tissue formed about terminal nerve filaments. The tenderness and neuralgic pains associated with these little growths are exaggerated when they occur in the mammary field; and they often give rise to great mental anxiety. They are benign, and should be excised. They are so small as to be easily overlooked; and it seems probable that in certain cases they may be the unrecognized cause of severe neuralgia of the breast.

Enchondroma; Osteoma; Myxoma.—True enchondroma and osteoma of the breast are extremely rare, if indeed they ever occur. Cartilage with bone, or a calcified area, is found occasionally in connection with other tumors, such as sarcoma, carcinoma, or fibro-adenoma.

Myxoma is very rarely found in the mamma. Fibro-myoma is somewhat less rare; clinically, it resembles fibro-adenoma.

Sarcoma.—The differentiation between sarcoma and fibro-adenoma, as observed in the female breast, is often extremely difficult, even with the aid of the microscope. As fibro-adenomata show fibrous tissue in various stages of development, it may be impossible to distinguish them histologically from certain types of sarcoma. The clinical distinctions between sarcoma and the soft and rapidly growing adeno-fibroma are also so poorly defined as to throw doubt on the diagnosis in many of the cases included in the published statistics of sarcoma of the breast. As compared with fibro-adenoma, and still more so with carcinoma, true sarcoma of the breast is of rare occurrence. All varieties of sarcoma are found in the breast; spindle-celled sarcoma probably occurring most frequently, round-celled sarcoma next, and giant-celled sarcoma rarely. Cystic degeneration is of common occurrence in these tumors. Mammary sarcoma is infrequent before the age of adolescence; Sheild having recorded only a single case in a girl of fourteen years. Of cases classified as sarcoma by Gross, the greater number occurred during the period of greatest functional activity *i.e.*, during the third and fourth decades; the average age being given as about thirty-five years. According to Sheild and Bryant, sarcoma of the breast is most common in middle or later life (past thirty or thirty-five years), less common in women about fifty, and rare in young women. (Bryant.)

Etiology.—The etiology of mammary sarcoma is obscure. Contusions or other injuries of the breast are often invoked as causative factors, and must, in certain cases, be recognized as an exciting cause.

Histology.—Microscopic examination of sections from different parts of the same tumor often shows different types of cells, making it difficult to assign a distinctive name to the sarcoma as a whole. The microscopic diagnosis of sarcoma turns largely on the fact that the cells are separated by intercellular substance, which, however, is often very small in amount. Certain sarcomata show indications of an alveolar arrangement; and an alveolar sarcoma of the breast has been described by even so competent an observer as Billroth. Histologically, sarcoma closely resembles normal embryonic or formative connective tissue (Fig. 384), of which it may exhibit nearly every step in development—from the soft, rapidly growing round-celled sarcoma, which closely resembles granulation tissue, to a hard tumor of slow growth, which may have become converted in great part into fibrous tissue, or even into cartilage or bone.

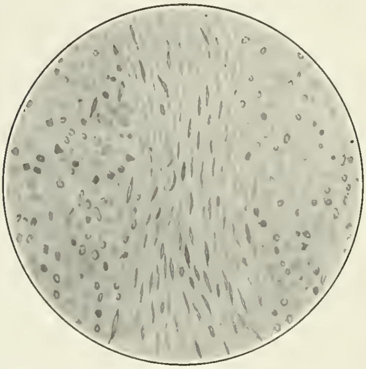

Fig. 384.—Section of Spindle-Cell Sarcoma of the Female Breast. Magnified about 100 diameters. (Original.)

Course of the Disease.—Sarcoma of the breast occurs ordinarily as a single tumor; rarely are there multiple tumors, and rarely are both breasts involved at the same time. The rapidity of growth is in relation to the more or less marked embryonic character of the tissue. The relative malignancy of the neoplasm is indicated by the comparative rapidity or slowness of increase. Most sarcomata of the breast undergo cystic changes; and in such cases there is often a discharge from the nipple. Hemorrhagic or other exudations into these cysts may give rise to sudden and alarming increase in size. When a sarcoma develops in the breast during pregnancy or lactation it grows with frightful rapidity, and goes on quickly to a fatal termination.

Diagnosis.—The diagnosis is attended in the beginning with great difficulty; in the later stages the mode of development, the relation of the tumor to the surrounding tissues, and the absence of any involvement of the related lymph nodes may afford data on which to base a definite diagnosis. Sarcoma usually thrusts aside, compresses, and causes atrophy of, the tissues of the breast. The cutaneous veins overlying the tumor enlarge early, and the skin looks thinned, stretched, congested, and pigmented, but is not infiltrated or thickened as in carcinoma. The skin is ordinarily not adherent to the subjacent tumor, and the regional lymphatics are only exceptionally enlarged. In rapidly growing sarcoma the local as well as the bodily temperature is increased; these manifestations simulating the febrile symptoms which accompany suppurative processes. In large sarcomata there is a distinct tendency to ulceration, due generally to gangrene from impaired nutrition rather than to infiltration of the skin. A fungous mass almost invariably protrudes soon after the skin has given way, but the edges of the ulcer are clean-cut, not thickened, and not adherent to the fungous mass.

Prognosis.—Local recurrence and visceral metastases are common. Dissemination takes place ordinarily by way of the blood stream. It seems certain that the growth, even when apparently encapsulated, spreads along the adventitia of the blood-vessels external to the capsule. A remarkable tendency to local recurrence of spindle-celled sarcoma has been noted.

Treatment.—An early, wide removal of the growth is the proper course. Bearing in mind the marked proneness to local as well as general recurrence, together with the tendency to spread along the blood-vessels, and recognizing the fact that the clearing out of the axilla and the removal of the pectoral muscles do not materially add to the seriousness of the operation, the writer believes that a radical operation should be performed. Especially important is this in the large or rapidly growing sarcomata, in which the prognosis is always grave; in the smaller, harder, more slowly growing sarcomata it may be permissible to halt with the amputation of the breast. Any local recurrence, however, unless known to be complicated by internal metastasis, calls for an immediate radical operation, with removal of the pectoral muscles and clearing of the axilla. In some instances of inoperable, recurrent cases, the injection of Coley's toxins into the tumor has been followed by marked diminution in size or even by apparent cure; *x*-ray treatment, also, may afford some amelioration.

Carcinoma.—Cancers comprise by far the greatest number of mammary tumors, the percentage being estimated at from eighty per cent to eighty-five per cent by different authors; about eighty-two per cent would seem to be very near the true proportion. The breast is also one of the organs most frequently attacked by carcinoma, the invasion of the disease being in close relation to sexual development, to functional activity of the organ, and to structural involution incident to or following the menopause. Vital statistics show an apparently marked increase in the prevalence of cancer, as indicated by a progressively increasing death rate throughout the civilized world. Moreover, as, with the single exception of the uterus, there is no organ of the body subject to such enormous variation in nutrition as the female breast, there is no reason to doubt that cancer of the breast shares fully in the general increase. Causes possibly predisposing to this increase have been sought in more abundant consumption of animal food, in a richer diet generally, in particular kinds of food, etc., but nothing has been definitely proved, nor does the study of the general conditions associated with cancer of the breast go very far in support of these or similar conjectures.

Etiology.—The primary cause of cancer of the breast, as of cancer in general, is unknown. It will be sufficient, therefore, to consider in this connection only those conditions which have been recognized as predisposing to its development. In many cases of carcinoma of the breast it is remembered that some local irritation or injury has preceded the development of the tumor, but it is generally impossible to demonstrate a directly causative relation, and in most cases no such history is obtainable. An injury to the breast may, however, awaken a latent tendency to carcinoma, especially when it has been received at a time when predisposition to the disease may be regarded as probable. Such cases come to the notice of every surgeon. Continuous mechanical irritation, intermittent or continuous pressure on the breast, as by a corset, etc., may thus be included among the occasional etiological factors.

The part played by heredity in the causation of cancer is undetermined. The percentage, in carcinoma of the breast, is variously estimated at from five per cent (Gebele) to 17.09 per cent (Horner). It is well known, however, that certain families show a predisposition to cancer. Mastitis, in its various forms and sequelæ, must be recognized as distinctly a predisposing cause. Breasts which have undergone cystic degeneration at the period of involution are prone to cancerous degeneration. The old scars left after acute mastitis are frequently starting-points for carcinoma. The great majority of cancers of the breast develop in women who have nursed. It seems certain that breasts which have attained or have passed through the stage of full physiological development, as in women who have borne children, are more prone than others to carcinoma. The influence of age in breast carcinoma is undoubted; by far the greatest proportion of cases occurring during the period of retrograde changes in the gland, in connection with or after the menopause, between the ages of forty and fifty.

Pathology.—Carcinoma is characterized by proliferation of atypical epithelial cells which progressively invade the contiguous tissues, with substitution of new histological elements foreign to the proper structure of the affected organ. According as the proportion of the fibrous to the epithelial constituents varies, it is convenient to distinguish the growths as hard and soft carcinomata, respectively. At the one extreme is the hard, scirrhous carcinoma, at the other the soft, medullary, or encephaloid carcinoma. In the latter variety the bulk of the tumor is made up of epithelial elements; in scirrhus the fibrous tissue is greatly in excess. Cancer originating in the epithelium of the acini—acinous carcinoma—is very much more common than cancer beginning in the epithelium of the ducts—duct carcinoma.

Mode of Dissemination.—Cancerous growths enlarge by progressive invasion of the surrounding tissues. The process has been investigated by Heidenhain, Stiles, Handley, Rotter, and others. Handley has made it clear that the growth of a cancer of the breast is by direct and continuous centrifugal extension along the lymphatics, the tumor increasing in size without material interruption of its continuity. There is no direct evidence of extension of cancer through the blood-vessels; and the fact, established by Goldman and Schmidt, that cancer cells, when they find their way into the blood stream, give rise to thrombosis, and that in the process of organization of the thrombus they are usually destroyed or rendered innocuous, would seem definitely to discredit the hypothesis of a dissemination of carcinoma by the blood. Cancer cells which have once found their way into the larger lymph channels are carried onward to the lymph nodes, where they give rise to metastases.

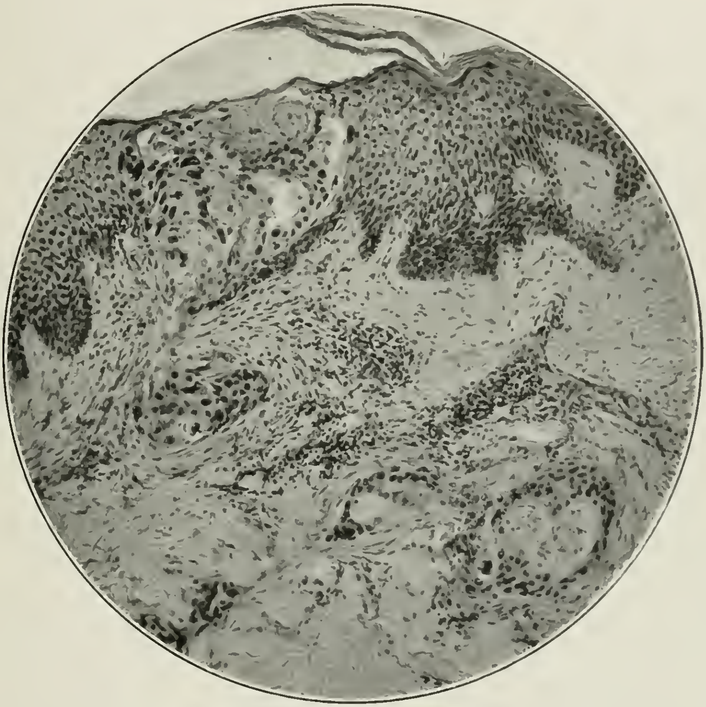

FIG. 385.—Cancerous Lymphangitis secondary to Cancer of the Breast (After John A. Fordyce, *Journal of the American Medical Association*, Oct. 24, 1908.)

The microphotograph shows the cancer cells in the lymphatics of the skin and the mode of the extension of the disease.

Handley has shown that dissemination occurs chiefly by the growth of the cancer cells along the lymphatics by a process which he calls "permeation." It seems clear, too, from evidence brought forward by other investigators, but most convincingly by Handley, that the centrifugal extension of cancer of the breast takes place primarily in the plane of the deep fascia, and that the infiltration of the integument, of the muscles subjacent to the deep fascia, and of the underlying viscera, is due to secondary lymphatic transmission in directions perpendicular to this principal plane. The occasional extension of cancer in the track of the blood-vessels may be explained as a growth of cancer cells along the accompanying lymph channels. Statistics show a distinct relation between deep metastases—in the bones, the thoracic and abdominal viscera, etc.—and the areas which have become invaded by subcutaneous cancerous nodules. The observation of Handley, that cancerous growths in the breast show a marked tendency to spread widely in the lymphatics along the fascial planes before involving the underlying tissues or organs, is of the greatest importance both from the pathological and from the surgical standpoint. The general shape of the growing tumor is approximately that of a biconvex lens, the greatest extension in depth corresponding to the greatest convexity in front. Dissemination takes place primarily by tendril-like lines of cancer cells reaching out from the growth by way of the finer vessels of the lymphatics plexuses (Fig. 385); embolic infarction of the regional lymph nodes follows; only in the most advanced stages of the disease do the cancerous products find a way into the blood stream. In general, the lymphatics which afford a path for cancer cells are in close relation to the veins and arteries. Lymph vessels accompanying the radicles going to the axillary veins lie along the outer edge of the pectoral muscle. A network of lymph vessels extends along the pectoral fascia to the axilla; and there is another network on the deeper surface of the pectoral muscle. Other lymph vessels accompany the blood-vessels that perforate the pectoral muscle and the perforating branches of the internal mammary vessels. Then, besides, it is important to remember that processes of the breast tissue may reach widely out into the surrounding fat, that the lymph vessels of the skin communicate with the lymphatic network surrounding the acini, that lymph vessels are found in the ligaments of Cooper, that obstruction of a lymph channel may be followed by the appearance of vicarious lymph channels, and that the migration of cancer cells—as has been shown by Handley—takes place almost as freely against as with the lymph stream. All these facts make it easy to realize in how many different ways breast cancer may spread beyond the site where it first appeared.

Scirrhus.—Scirrhus is by far the most common form of acinous carcinoma. In the beginning of such a cancerous growth the single layer of epithelial cells (columnar or polyhedral) lining the cavities of the acini and finer ducts takes on an atypical proliferation; the new cells crowding the acini and ducts, and giving rise to the characteristic epithelial nests or columns. These irregular cells, breaking through the basement membrane of the acini and ducts, find their way into the adjacent connective-tissue areas and lymph spaces. The resultant carcinoma is thus made up of two principal constituents, epithelial cells or parenchyma, and a stroma of connective or fibrous tissue with blood and lymph vessels. In scirrhous cancer there is marked proliferation of the connective tissue, while the proliferation of epithelial cells takes place so slowly that the fully developed tumor may show many alveoli only partially filled with cells, and the cellular elements of the growth perhaps limited to slender strands sparsely scattered through the general mass. (Fig. 386). Such a growth remains hard and nodular, and seldom attains any great size; the dense connective tissue contracting upon and compressing the alveoli and ducts, and causing early degeneration of the epithelial cells. There is seen occasionally an atrophic or withering form of scirrhus, which is clinically of extreme importance. The epithelial elements undergo fatty degeneration and disappear, leaving little more than a contracted mass of fibrous tissue with here and there small groups of atrophied cells and débris; a condition probably due to an exceptional development of the fibrous stroma, with diminution of the blood supply incident to its progressive contraction.

Microscopically, it may be difficult to distinguish a section of an old atrophic scirrhus from ordinary scar tissue. Clinically, the shrinking of the growth is so pronounced as oftentimes to give rise to an appearance as if the breast had been removed. (Fig. 387.) The gross appearance of such a growth may very closely simulate the condition seen in certain rare cases described by Billroth as chronic atrophic (shrinking) mastitis. Atrophic scirrhus occurs especially in spare and lean women, in the weak and aged, and in persons with feeble circulation; oftenest in women past sixty years. In the earlier stages the course of the disease is much the same as in ordinary cases of scirrhus, the tumor increasing slowly up to the stage of involvement of the skin. After this the growth of the tumor is arrested, the ulcer contracting and becoming hard, and often deeply colored; hence the name "rose cancer," by which this variety is known to the laity. As an indurated indolent ulcer with scanty discharge, or as a dry desquamating depression, atrophic scirrhus may persist for many years with but little annoyance to the patient and practically no disturbance of the general health.

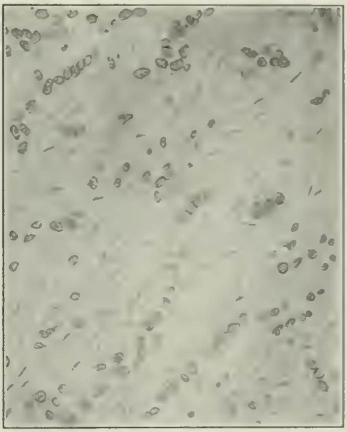

Fig. 386. Section of a Scirrhous Carcinoma of the Female Breast. Magnified about 200 diameters. (Original.)

Medullary Carcinoma.—In this variety of cancer the sparse and loose stroma is filled with epithelial "nests" of varying shape and size, the cells being often without definite arrangement, while in other cases they are more regularly grouped, somewhat in semblance of gland tissue. The epithelial cells crowd the alveoli and invade the adjacent lymphatic vessels and spaces and connective-tissue areas. The parenchyma predominates, with scanty development of connective tissue (Fig. 388); the tumor has a rich blood supply, and the cells proliferate rapidly. The tumor therefore grows with great rapidity, reaching a large size in a few months. It is of a prominently hemispherical form (Fig. 389) and soft, not infrequently presenting fluctuating hemorrhagic areas, while the remainder of the growth feels elastic or semi-fluctuant. Medullary carcinoma is typically malignant. The average duration of life is about twelve months, but the progress of the disease may be much more rapid, especially if it develops during pregnancy or lactation, when it may go on to a fatal termination within a few weeks. This form of carcinoma of the breast is fortunately rare. As compared with scirrhus, it is distinctively a disease of earlier life.

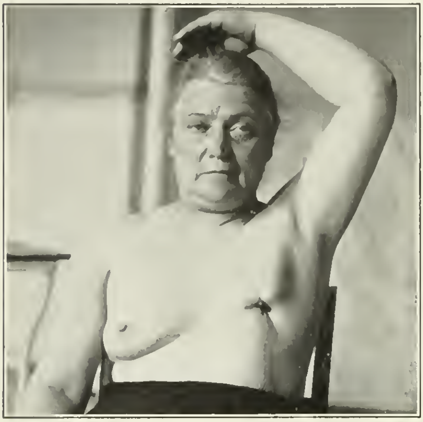

FIG. 387. Unoperated Scirrhous Cancer of Left Breast, of eighteen years' standing. (Clopton.) The photograph shows complete disappearance of the mammary gland. No skin metastasis. Axillary involvement has existed nearly two years.

Adeno-Carcinoma.—Adeno-carcinoma or carcinoma simplex is a form of cancer intermediate in structure between scirrhus and medullary carcinoma, the proportion of the parenchyma to the stroma being approximately the same as in the normal mamma. (Fig. 390.) Clinically, it is of comparatively slow growth, and is distinctly less malignant than scirrhus; the prognosis after operation being much more favorable. Halsted reports a percentage of cures, in adeno-carcinoma of the breast, of seventy-five per cent, as against 35.5 per cent in scirrhus.

Duct Cancer.—Cancer originating in the lactiferous ducts is of comparatively rare occurrence. Arising from the columnar epithelial lining of the ducts, the cells retain something of the same columnar form, and vestiges of tubular structure may be conserved in portions of the growth. Duct cancer is often preceded by or associated with cystic degeneration of the gland. It is softer than scirrhous cancer, and is ordinarily not nodular; there is no retraction of the nipple or dimpling of the skin. Duct cancer is generally painless, and it is distinctly less malignant than the acinous types of cancer. The growth of the tumor is also slower, infiltration progresses less rapidly, and invasion of the lymph nodes occurs later. Duct cancer begins as a rule in the neighborhood of the nipple.

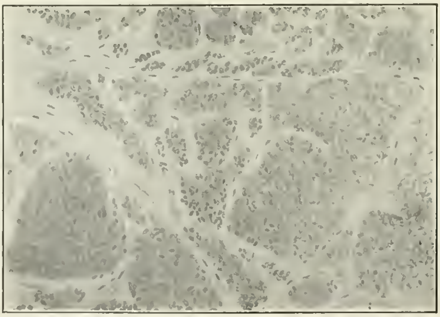

FIG. 388. Section of a Medullary Carcinoma of the Female Breast. Magnified about 100 diameters. (Original.)

Not infrequently there is a serous or bloody discharge from the nipple, or a serous, bloody, or colored fluid may be squeezed from the nipple.

CLINICAL COURSE OF THE DISEASE.—The general clinical course of mammary cancer is progressively from bad to worse; but the unknown factors which may hasten or retard the progress of the disease make it impossible to forecast the probable duration of life in particular cases. The estimate of Sir Astley Cooper—from two years and six months to four years, in cases not operated on—is certainly excessive for the great majority of cases. A patient may die within a year after the discovery of a cancerous nodule, or may live many years. Cases are recorded of patients, with scirrhus, living for twenty-four years. Sooner or later, as a rule, the cancer invades the overlying skin and ulceration ensues. The ulcer may be superficial or deep, more frequently the latter; the deep, crater-like cavity showing indurated and irregularly nodular margins, while the base is covered by unhealthy, sloughing granulations of cancer tissue and exudes a thin, sanious, fetid discharge. Intercurrent hemorrhage may occur. Pain is often unbearable, or it may be but slight. In some cases of cancer the integument becomes widely infiltrated, hard, and board-like; the growth forming adhesions with the thorax, the chest wall becoming rigid, and the respiration distressingly impeded. Velpeau gave to this variety of cancer the name "cancer en cuirasse." (Fig. 391.)

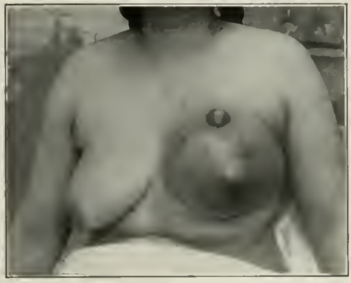
FIG. 389.—Medullary Carcinoma of the Female Breast. (Original.)

When carcinoma occurs in the aged it grows, as a rule, slowly. The lymphatics may remain apparently unaffected even after the disease has existed for many years. Instances have been recorded of patients suffering with atrophic scirrhus for as long a period as twenty-four years, and dying from other causes. Gross reported a series of eight cases in which the average duration of life was fourteen years and nine months. It must be borne in mind, however, that metastases may occur even after the lapse of years. Secondary deposits in the bones and viscera are not infrequent; the disease ultimately destroying life.

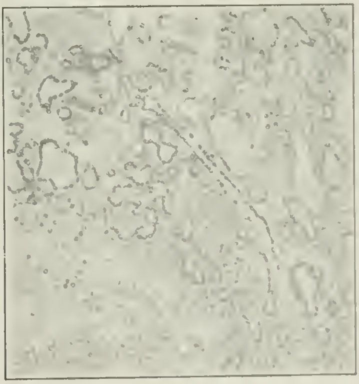
FIG. 390. Section of an Adeno-Carcinoma of the Female Breast. Magnified 100 diameters. (Original.)

The atrophic process may occur in isolated nodules, which wither and disappear, while new deposits form in other parts of the growth. Bryant and Nunn have noted the spontaneous disappearance of individual cancerous nodules which had recurred in the scar after operation. Visceral or bone metastases not infrequently occur when the primary tumor in the breast is still so small and apparently insignificant as either not to have been noticed or not to have been associated with the symptoms which have attracted attention to a secondary metastatic growth. The average duration of life in typical scirrhus of the breast is about two and one-half years, but with notable variations from the mean.

When the cancerous process spreads in the superficial lymphatics, we sometimes see the skin of the thorax and abdomen studded with innumerable nodules, varying in size from a buckshot to a marble. The name "lenticular cancer" has been given to this variety. (Fig. 392.) Such widespread dissemination is usually associated with deposits in the viscera—the pleura, liver, etc. Pain may be exhausting; death may result from the toxæmia induced by the growth or from general sepsis. Metastases may give rise to paraplegia, cerebral softening, or embolism, and may thus hasten the inevitable end. "Cancer en cuirasse" may cause death by suffocation. Scirrhous cancer of the breast forms an irregular nodular mass of stony hardness, without definite limitation, inseparable from and merging insensibly into the surrounding mammary tissue. The cancerous growth becomes adherent to the skin and later to the subjacent tissues, the whole mass ultimately becoming fixed to the chest wall. Some scirrhous cancers grow slowly and do not attain great size. When the primary growth is located near the nipple or spreads to its neighborhood, the nipple gradually becomes retracted. The fibrous bundles connecting the gland tissue with the skin become infiltrated with cells, new fibrous tissue forms, and this in contracting draws on multiple points of the skin, producing the characteristic fine pitting ("peau d'orange," or "pig skin") of cancer. (Fig. 393.) In the rapidly growing, soft, or medullary carcinoma, lymphatic involvement and metastases usually occur very early. In some cases of exceptionally rapid growth, the skin becomes adherent and takes on a glazed and reddened look which closely simulates, and may even be mistaken for, an abscess. The adherent skin soon ulcerates, and masses of the tumor

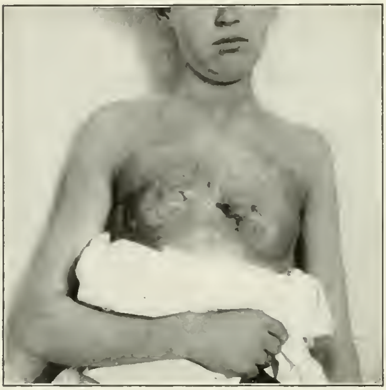

Fig. 391.—"Cancer en Cuirasse," Involving Both Breasts. The present photograph was taken when the patient was twenty-two years of age,—*i.e.*, four years after she first noticed the presence of any evidences of cancer. (Courtesy of Dr. Franz Torek, New York Skin and Cancer Hospital.)

may slough away, leaving large excavated sores. Cachexia occurs early, and is a regular accompaniment of lymphatic involvement and visceral metastases.

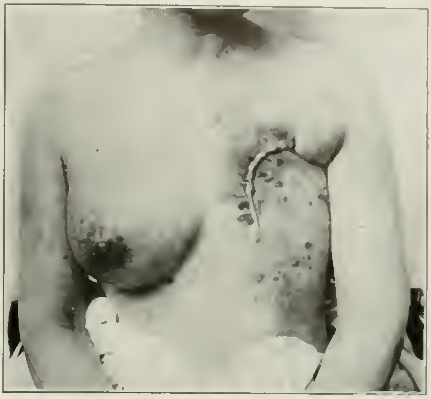

Fig. 392.—Lenticular Recurrent Carcinoma in the Scar Left by a Former Operation for Removal of a Cancerous Breast. (From St. Louis Skin and Cancer Hospital.)

A condition called by Osler "mastitis carcinomatosa," by Charbonnier "Cancer aigu du sein," cases of which have been described also by Billroth, Aiken, Volkmann, and others, is characterized by the appearance of a diffuse, rapidly spreading infiltration which gives the impression of a progressive inflammation rather than of a new-growth. This widespread regional metastasis extends rapidly beyond the limits of the breast, quickly involving the side of the chest, the other breast, the shoulder, or even the arm. Osler mentions a case in which both breasts were involved and in which the infiltrated areas met in front and extended over the back almost to the spine; also another case in which the course was more chronic, extending over a year. In the greater number of cases both breasts are involved. The breast becomes enormously enlarged, the skin becomes brawny; no nodules are found. The lymph nodes above the clavicle usually enlarge, and the arm may swell.

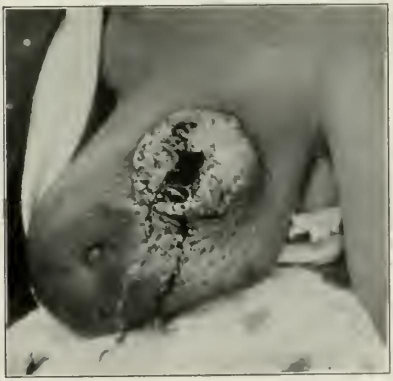

Fig. 393.—Ulcerating Carcinoma of the Female Breast, with the Characteristic Pitting of the Skin known as "Pig Skin." (From St. Louis Skin and Cancer Hospital.)

In some cases of scirrhous carcinoma the growth may have been present for a considerable time before it is discovered. Widespread secondary lesions—such as pleural deposits accompanied by effusion, enlarged cervical lymph nodes, lesions of the bones, etc.—may develop from a small or possibly undiscovered tumor of the breast. Osler has described a condition which he calls "paraplegia dolorosa," due to secondary deposits in the spine, and he has emphasized the necessity of a careful examination of the mammary glands in obscure affections of the bones, viscera, and spine. In certain cases it has been found that such troubles are due to metastasis from a previously unrecognized cancer of the breast.

The course of cancer of the breast is more rapid in younger subjects; and if pregnancy occur and lactation be established, the tumor may grow very rapidly and the downward progress of the patient be very swift. Extraordinary variations are occasionally observed in the clinical course of cancer, and a knowledge of these may save the surgeon from serious mistakes in prognosis. As a result of interference with the blood supply, masses of cancer may become gangrenous and slough away. The patient, thus relieved of a source of septic infection, may improve greatly in general condition, and the ulcer may even partially cicatrize. It is a well-attested fact that marked improvement sometimes follows an attack of erysipelas. Not only has the tumor ceased to grow, but it has even diminished in size. Atrophy or withering of a scirrhus is recognized by all writers as occurring occasionally in old and spare subjects. The duration of an atrophic scirrhus often extends over many years. This form of the disease is usually almost painless, and in some cases the general health may for years show little or no impairment. The lymph nodes are ordinarily affected late, but in the end they become implicated. Visceral metastases are common, and ultimately they destroy life. It is important to bear in mind the fact that in certain cases nodules of cancer may undergo atrophy and disappear; new nodules appearing later in other parts of the breast. Patients suffering from atrophic scirrhus frequently seek advice only after the disease has existed many years; hence the surgeon, before he advises interference, must be careful to ascertain that internal metastases do not already exist. He must remember also that cases of atrophic scirrhus occasionally assume a rapidly fatal course after operation.

Diagnosis.—In the early diagnosis and radical removal of cancer of the breast lies our hope of securing better results in this dread disease. A positive diagnosis is not always easy, or even possible, but the imperative necessity of an early and complete investigation of every case of tumor in a woman's breast cannot be too strongly impressed on the profession and on the laity. Diagnosis may occasionally be impossible without surgical exploration; and in such doubtful cases, as Mr. Sheild puts it, an exploratory operation is quite as important as it is in an obscure case of abdominal tumor. The symptoms most commonly associated with carcinoma of the breast are pain, a lump in the breast, enlarged axillary lymph nodes, more or less complete fixation of the tumor, retracted nipple, fine dimpling of the superimposed skin—the so-called "pig skin"—and, in the later stages of the disease, cachexia and loss of weight and strength. Pain, so important a symptom in advanced cases of cancer, is often entirely absent in the earlier stages; hence, in the early diagnosis of a small, doubtful tumor, too much stress should not be laid on this feature. The pain of mastitis, of a cyst, or of an abscess, or the neuralgic pain in fibro-adenoma, may be confusing.

In examining for cancer of the breast it is essential to bare the entire thorax, so that a thorough inspection may be made, and any asymmetry noted. The surgeon is also enabled to make a thorough examination of both breasts, and of the axilla and the supraclavicular region on both sides.

The examination of the breast itself calls for the exercise of all the skill which it is possible to acquire by practice and the closest attention to details. This examination is best made by pressing the gland against the chest wall, with the hand placed flat on the breast. Any definite tumor or cyst will be felt as a distinctly circumscribed mass; whereas the tumefaction in a case of mastitis without cyst formation gives no such impression of a well-defined lump, but rather that of a general swelling. The examination may be made with the patient lying on her back or, better still, sitting in a chair supported by a firm back; the surgeon stands behind and reaches over the patient's shoulders, in which position he will be able to palpate both breasts simultaneously, and to note any difference in density. The nodule or mass, which in cancer is generally hard, may be difficult or impossible to distinguish from a tightly distended small cyst or from a cyst with thick walls, especially if situated deep in the breast and buried perhaps under several inches of fat.

Enlarged lymph nodes are a symptom of uncertain value in the early diagnosis of doubtful tumors of the breast. They may be enlarged, and yet not be cancerous, as in mastitis, tuberculosis, syphilis, etc. On the other hand, lymph nodes already infected with cancer cells may not be enlarged, and so may escape discovery by palpation. There can be no doubt that the axillary lymph nodes are almost invariably implicated even in the very early stages of cancer of the breast. The inability to feel enlarged nodes in the axilla counts, therefore, for little or nothing in the diagnosis.

In the early stages of carcinoma the tumor is movable on the chest wall, and the superimposed skin is movable over the tumor. The tumor itself does not move within the breast. This may be, however, a difficult point to determine early, when the tumor is small; the sliding of the skin over the breast, or of the breast on the chest wall, being hard to distinguish from mobility of the tumor within the breast tissue.

Retraction of the nipple occurs as an early symptom only when the tumor starts beneath or in the near neighborhood of the nipple. In cancerous tumors which develop toward the periphery of the breast, retraction of the nipple occurs late, or not at all. Retraction of the nipple may occur also from other causes: from cicatricial contraction following the healing of an ulcer or fissure, as a result of swelling or induration of the tissues about the nipple in mastitis, or as a part of the general shrinking of the breast which takes place in chronic atrophic mastitis.

The punctate dimpling of the integument of the breast ("pig skin," peau d'orange), due to contraction of the very numerous fine bundles of fibrous tissue which connect the skin with the superficial fascia, is distinctly pathognomonic of cancer. A very slight shortening of the trabeculæ which pass from the tumor to the superficial fascia and the skin (ligaments of Cooper) serves as an indication of the presence of cancer in the breast. This shortening is made evident by the pull exerted upon the skin when the breast is made to take a wide excursion on the chest wall. Halsted lays great stress on this indication. He says: "The faintest conceivable trace of a difference on the two sides, in a minor pectoral crease, for example, may suffice for the diagnosis"; and he has repeatedly performed the complete operation for small deep-seated cancer, without exploration, where there has been a mere trace of asymmetry in the skin-tugs on extreme displacement of the breast. He says, further, that an "almost imperceptible suggestion of pull, which, when the faintest possible, is of course elicited by dislocation in one direction only," is all that is necessary for a diagnosis. It is, of course,—to quote again,—"only under the most accurate control with the other breast that its significance in difficult cases may be estimated."

It may be difficult or impossible to differentiate a deep abscess from a cancerous nodule; especially when the abscess has developed slowly or has existed for a long period. Such an abscess has often a very thick, hard wall; and many breasts have no doubt been needlessly sacrificed through mistaking an indurated abscess for a cancerous mass. These cases may give no history of fever or tenderness, and the lymph nodes are sometimes enlarged and hard. To avoid error in these doubtful cases Dawbarn advises the adoption of a diagnostic suggestion made by Syme:—"That whenever an operator is not perfectly certain of the correctness of his diagnosis of mammary carcinoma, because of the absence of one or more of its cardinal symptoms, such as retraction of the nipple, his first operative step should be to cut, with a single stroke, into the very midst of the supposed neoplasm." If no pus is found, Dawbarn directs that the incision in the tumor be tamponed forthwith with gauze wrung out from a strong antiseptic solution, and immediate extirpation performed.

It is often extremely difficult to differentiate a mammary cyst from carcinoma. A tense cyst makes itself felt for a considerable distance in the surrounding breast tissue, particularly when the breast is fibrous in texture. Even a very small cyst, by reason of the pressure which it exerts in the dense tissue of a fibrous mamma, may shew on palpation a very distinct, circumscribed hardness. The fact that chronic cystic mastitis, with marked development of fibrous tissue, occurs about the time of the climacteric, when we may look for the development of cancer of the breast, and the additional fact that this form of mastitis is the one most liable to malignant change, make the differentiation between cyst and carcinoma often extremely difficult and sometimes impossible. In such a case a tentative removal of the mamma, with preparation for an immediate complete operation, should always be made. Much may thus be discovered from macroscopic appearances. Scirrhous carcinoma cuts like cartilage, and the cut surface is hard and rough and has been likened to the cut surface of an unripe pear. The cut surface usually becomes somewhat cup-shaped, and when scraped yields a thick milk-like juice. As an additional means of immediate identification Stiles directs that, after the blood has been washed off, the breast be placed in five-per-cent nitric acid for about ten minutes, and then washed in running water for three or four minutes. The acid gives an opaque whiteness to all tissues except the fat, this effect being due to coagulation of the albuminous constituents. By the subsequent washing in water, the connective tissue becomes translucent, homogeneous, and somewhat gelatinous, while the breast parenchyma remains opaque, white, or grayish. The cancerous tissue behaves like the parenchyma, becoming even more densely opaque.

Contrary to common belief, cachexia is ordinarily not an early symptom of carcinoma, but becomes marked later in the disease, when pain, ulceration, loss of sleep, and absorption of septic products have worn the patient down.

Hæmolytic Reaction in the Diagnosis of Cancer.—A comprehensive clinical research, by Crile,[*] on the action of the blood-serum of cancer patients in breaking down the red corpuscles of human blood drawn from a healthy person, has yielded results pointing to a new departure in the differential diagnosis of doubtful tumors of the breast at a period in their development when other diagnostic methods leave so much to be desired. Of a total of eighty cancer patients observed during a period of eight months, there were sixty-six,[†] including all but one of the eighty patients who were still in a less advanced or operable stage, who showed a positive hæmolytic reaction. Of the remaining fourteen patients who showed either no reaction or a reverse hæmolysis (breaking down of the red corpuscles of blood drawn from a cancer patient when mixed with blood-serum from a healthy person), "all but one were either inoperable or very advanced." "Cured cases showed no hæmolysis." "Patients . . . with benign tumors showed no reaction." "In chronic suppurations . . . no hæmolysis occurred." "In the cases of tuberculosis those showing hæmolysis showed a much greater autolysis than hæmolysis, thus giving a characteristic reaction." "In a uterine fibroid, without suspicion of malignancy, . . . hæmolysis occurred, and at operation sarcomatous transformation at the centre of the tumor was disclosed." "In one hundred and twenty-five normal individuals there was hæmolysis in no instance."

Previous investigations (Kelling, 1905,[‡] 1907;[§] Rosenbaum, 1907[‖]), made with blood of oxen, sheep, swine, and hens, had shown a hæmolytic reaction in from forty-five per cent (Kelling) to fifty-four per cent (Rosenbaum) of cancer cases. Hæmolysis had also been demonstrated in a very large proportion of tested cases of sarcoma, in a rather wide range of diseases, mostly infectious, and in patients nourished largely on raw eggs.

TREATMENT.—The complete removal of the cancerous breast, together with all infected tissue, affords the only hope of a radical cure.[¶] Pathologists agree that carcinoma is primarily a local affection, and that, when all the diseased tissues have been removed by operation, it does not recur. So-called recurrence is, then, only a subsequent growth of portions of diseased tissue which have been left behind at the operation. The appearance of these subsequent growths may, however, be long delayed, in some instances even for many years. In the operative treatment of cancer, therefore, it is the duty of the surgeon to remove not only the entire breast, but, so far as is possible, all tissues likely to be involved in the dissemination of the disease. Outlying foci of cancer are often invisible to the naked eye; but, in any case in which microscopic examination reveals such foci, it is certain that the cancer cells have already become widely disseminated in the lymphatic spaces. It is evident, therefore, that the dissemination may possibly have begun long before the discovery of the tumor. Unfortunately, the tumor must ordinarily be first discovered by the patient, and a scirrhous cancer large enough to have attracted her attention must always be regarded as already more or less widely disseminated. The researches of Handley, showing that dissemination occurs almost invariably as a direct extension by permeation through the lymphatics, and that the most rapid extension takes place along the planes of the deep fasciæ, leave no room for doubt that an operation for cancer of the breast should always be complete, and should include the removal not only of the entire gland but also of the underlying fascia and pectoral muscles, of a large area of the skin covering the tumor, and of a much more extended area of fat and fascia. The axilla should be thoroughly cleared of fat, lymph nodes, and connective tissue; and, whenever there are signs of enlargement of the axillary nodes, the sheaths should be stripped from portions of the serratus magnus and the latissimus dorsi muscles. The dissection should include also the stripping of the sheath from the upper part of the rectus abdominis muscle. When there is evidence of involvement of the subclavian group of lymph nodes, the supraclavicular triangle should also be carefully cleared out as high up as the bifurcation of the carotid artery; all the fat, connective tissue, and lymph nodes—even the solitary node which is situated at the junction of the jugular with the subclavian vein—being removed. In operating on the left breast, the possibility of wounding the thoracic duct at this point must be kept especially in mind. It is not always possible to make a satisfactory dissection of the supraclavicular triangle without cutting through the clavicle, but this is to be avoided if practicable. In the primary operation, adequately performed, lies the patient's greatest hope of a permanent cure. Especially is this true in cases of cancerous cyst, or of cystic disease of the breast which is undergoing malignant transformation—a class of cases in which the diagnosis is sometimes extremely difficult, and in which, for this reason, an exploratory incision, or excision, may be necessary. *Only a complete primary operation* is of any avail in such cases; a partial operation generally doing harm by accelerating the dissemination of the disease, and secondary operations, however promptly performed, proving of little effect in prolonging life.

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[*] Journal of the American Medical Association, June 6th, 1908.

[†] The numbers in Crile's paper are given for the most part in percentages; 82 per cent of 80 cases gives 65.6.

[‡] Archiv f. Chirurgie, Bd. 80, Heft 1.

[§] Berliner klin. Wochenschrift, 1907, No. 42.

[‖] *Ibid.*, 1907, No. 42.

[¶] The patient shown in Fig. 395 was first seen in January, 1902, with an extensive carcinoma of the left breast which had been declared inoperable by a very competent man. The outlook was explained to her. She wished to take any possible chance for relief. The complete operation was performed. Three years later, December, 1904, carcinoma developed in the right breast. This was removed, also by radical operation. Small recurrent nodules in the scar had already been removed several times from the left breast. In January, 1908, I received from this patient a letter in which she says: "My [first] operation was on January 7, 1902; I have been on the table seven times, and it is now just six years since my first operation. I think my health has never been as good as it has been this winter."

By a complete operation, we mean an operation planned and executed with a view to preventing local or external recurrence. No operation can properly be classed as complete in the sense of protecting against internal recurrence, for internal metastasis may already exist at the time of the primary operation. Many forms of incision have been devised with a view to facilitating the closure of the wound, but no incision should be considered which in any degree limits the removal of so much of the skin as may be suspected of being implicated in the carcinomatous process. The suggestion made by Follis, that the man who is to close the wound should not have the planning of the skin incision, is pertinent as emphasizing this point. Removal of a large area of skin adds nothing to the operative risk, and but little to the difficulty of properly closing the wound; the ultimate safety of the patient should alone be taken into consideration. Other things being equal, that incision which is the simplest, and which enables the operator to make the best use of any redundant or available skin, is the best for the purpose. In many cases no attempt should be made to bring the margins of the skin together over the entire wound, but skin-grafting should be resorted to at once. In view of the close anatomical relation of the breast to its skin covering, rendering this entire area of skin especially liable to early pathological involvement, it is safest, in all cases, to remove the skin over the entire breast. Rotter advises the removal of three finger-breadths of skin beyond the limits of the breast. When the growth is adherent to the skin, or when the tumor is near the breast margin, even a more extensive removal of skin may be necessary. In all cases the incision should be in distinctly healthy tissue, cutting wide of any suspected portion. There is little danger of removing *too much* skin; but there is *great danger* in removing *too little*. The dissection of the skin should be so made as to leave a minimum of adherent fat, as there is always danger from dissemination by way of the lymphatics in the fat overlying the breast. As cancer tends to spread widely by the lymphatics in the planes of the deep fasciæ, and especially in the retro-mammary fasciæ covering the pectoral muscles, a very extensive extirpation of the tissues in this region is absolutely essential. Extirpation should be carried as far downward as an inch or two below the tip of the ensiform cartilage, the sheath being stripped from the rectus muscle to the same extent; for it is here that Handley has found that the cancerous process often finds a way to the liver and abdominal viscera. The removal of the deep fascia should include also the stripping of the sheath from the parts of the muscles forming the boundaries of the axilla. Both the pectoralis major and the pectoralis minor muscles should be removed, as cancerous foci are not infrequently developed in the body of the pectoralis major, and cancerous nodes are often found between the pectoralis major and the pectoralis minor. The removal of the pectoral muscles also makes possible a clean and complete removal of the axillary lymphatics. The operation should be carried out in such manner that all the structures mentioned, including the entire breast, are removed in a single mass, and that no portion of the breast tissue is cut into or exposed to view during the operation. When the cancer is found to be so far advanced that the lymph nodes have become adherent to the wall of the axillary vein, such portion of the vein as is found to be so involved should be removed.

The operator should plan his incision with a view to the removal of all skin tissue which may possibly be carcinomatous, bearing in mind also the importance of ready access to the entire field of operation, and the desirability of making as satisfactory a restoration of the axilla as possible. He should be prepared to utilize all available skin to the best advantage in covering the axilla and in closing the thoracic wound, supplementing it, as may be necessary, by skin-grafting. Any attempt to regulate the skin incision so that it shall fit a particular plan of closure is, in most cases, to be condemned. The incisions described by Kocher, Warren, Jackson, and others lend themselves, in some cases, to immediate closure of the wound by sliding and fitting of the skin, and may therefore be kept in mind. (Fig. 394.) Whatever the plan of incision adopted, the subsequent operative procedure should be begun by dividing the pectoral muscles near their respective insertions, working progressively from the axilla toward the median line. The early complete exposure of the axillary vein renders the thorough clearing of the axilla easy and safe, and the cutting off of the greater part of the blood supply by the early ligation of the vessels leading from the axilla to the breast renders the operation much less bloody than when the dissection is begun from the median side of the breast. The comparative bloodlessness of this procedure makes possible a more rapid and easy dissection, shortens the time of operation, and minimizes the resultant shock. The removal of the major and minor pectoral muscles best exposes the lymphatics, and enables the operator the better to

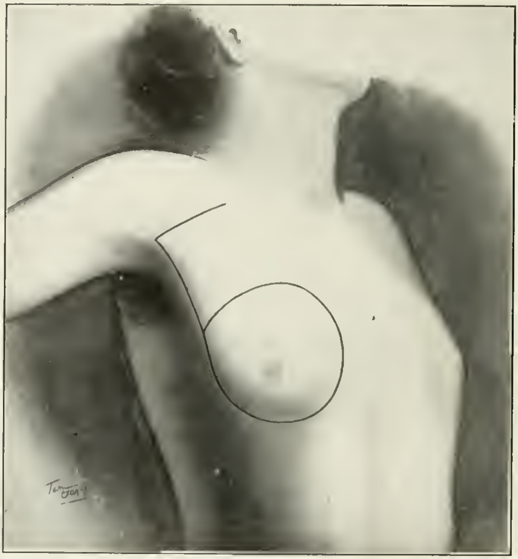

FIG. 394.—The Incision Recommended by Dr. Jabez Jackson is shown in this illustration. It may be used in early cases, where the skin is not widely involved.

remove all infiltrated tissue. The lymphatic trunks lying along the lower border of the pectoralis major, the subclavicular lymph nodes between the pectoralis major and the pectoralis minor, and the lymph channels perforating the muscles can in no other way be so surely and safely removed. An additional advantage in making the dissection from the axilla inward is that it eliminates a very real source of danger from handling or squeezing the cancerous breast during the operation. The possibility of forcing cancerous products along the conducting lymph channels, including even the possibility of pressing cancer elements into the venous circulation, is too obvious to be disregarded. When the operation is begun by clearing the axilla, the continuity of the lymphatic connections between the morbid growth and the body is broken, and the risks from inevitable massaging of the breast incident to handling it are reduced to a minimum. The removal of the pectoral muscles, while it adds immeasurably to the safety of the patient, does not interfere with the subsequent free movements of the arm, which continue to be satisfactorily performed by the other muscles. On the other hand, when the pectoral muscles are not removed, or when only the muscular sheath is stripped off, there often results an inflammatory condition which seriously limits the motion of the arm for an indefinite period. Removal of these muscles is therefore not only an indispensable part of any complete operation, but is also essentially a conservative procedure. Removal of both breasts, together with the pectoral muscles on both sides, does not interfere with the practically perfect conservation of the movements ordinarily effected through the action of the pectoralis major muscles. (See Fig. 395.)

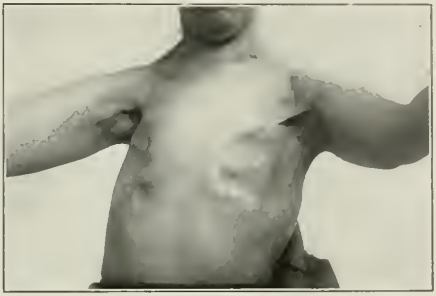

Fig. 395.—Photograph taken Six Years after the Removal of the Left Breast and Four Years after the Removal of the Right Breast. It shows the restoration of muscular function after the removal of the pectoral muscles of both sides. (Original.)

Technique of the Operation.

It is the practice of the writer to mark, by light touches of the knife, the boundaries of the portion of the skin which it has been decided to remove. (Fig. 396.) The incision is usually begun near the middle of the clavicle and perhaps an inch below the bone, and is carried in a downward and outward direction to the border of the axilla. The skin is then dissected from the subjacent tissues until the cephalic vein, lying between the bodies of the deltoid and the pectoralis major, is exposed. The pectoralis major muscle having been separated from the deltoid by blunt dissection, the index finger is slipped under the body of the pectoralis major, which is then cut through near its insertion into the humerus. The muscle immediately retracts toward the chest, exposing the pectoralis minor muscle invested by its fascia. This muscle is easily and quickly uncovered, the index finger passed under it, and its insertion into the coracoid process of the scapula divided; whereupon the muscle immediately contracts and opens up the axillary space. The wound is next held open by retractors, or by the fingers of an assistant, thus exposing the axilla freely to view from the front. The fascia covering the axillary vein is now cut, to the outside of the vein, and the dissection is carried inward; the fascia should be stripped from the vessels and the axillary plexus of nerves, and with the fascia all the fat, lymph nodes, and connective tissue should be removed in a single mass. The dissection should also uncover the axillary vein and artery together with their branches going to the axilla and to the chest. These branches are at once divided between clamps and ligated. The fascial covering is next stripped from the muscles along the posterior boundary of the axilla, thus completing the dissection in this region. The skin incision is now extended downward and carried round the breast far enough to include as much of the integument as it has previously been decided to remove. The skin is dissected from the subjacent tissues as far as the sternum, and as little fat as possible is left adhering to it. (Fig. 397.) The entire mass, including the pec-

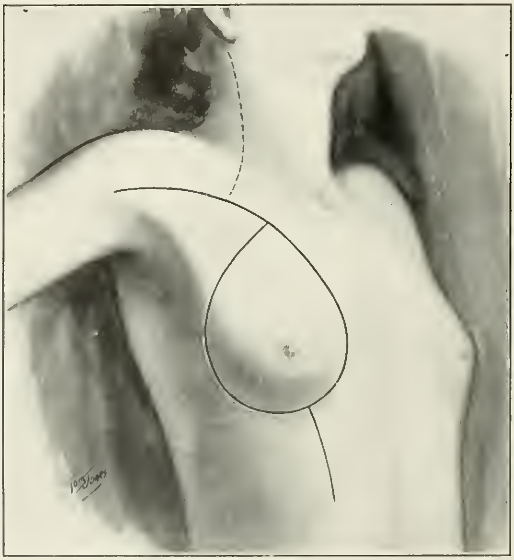

Fig. 396.—This Illustration Shows Incision Ordinarily Employed for Radical Removal of Carcinoma of the Breast. The dotted line above shows the additional incision used when neck dissection is necessary. (Original.)

toral muscles, the breast, the fat, and a large area of the deep fascia, is now to be removed entire; it should be lifted from the chest wall, at its outer side, in such a manner as to bring into view the perforating branches of the internal mammary vessels, which must be caught and tied. Any remaining attachments of the pectoralis major muscle to the clavicle are also to be divided. The mass having been rolled still farther inward and lifted from the thorax (Fig. 398), it only remains, to complete the operation, to cut through the pectoralis minor and the pectoralis major, where they are implanted on the ribs and sternum. (Fig. 399.) When hæmostasis is complete, attention must be given to the closure of the wound. A rubber drainage tube is first carried up to the point where the axillary vein passes under the clavicle, and is brought out through a stab wound in the most dependent portion of the wound cavity behind. The skin at the posterior margin of the wound is utilized, so far as may be, in closing the axillary space, which is in this way practically obliterated. If there is still sufficient skin left to admit of a sliding or plastic procedure, for the purpose of covering the remaining wound without too great tension, this procedure should be carried out. In case there is a lack of sufficient skin to effect perfect closure, immediate recourse should be had to skin-grafting. The drainage tube in the axilla may be removed at the end of forty-eight hours. The wound is dressed with the arm held close to the chest and included in the bandage which holds the dressings.

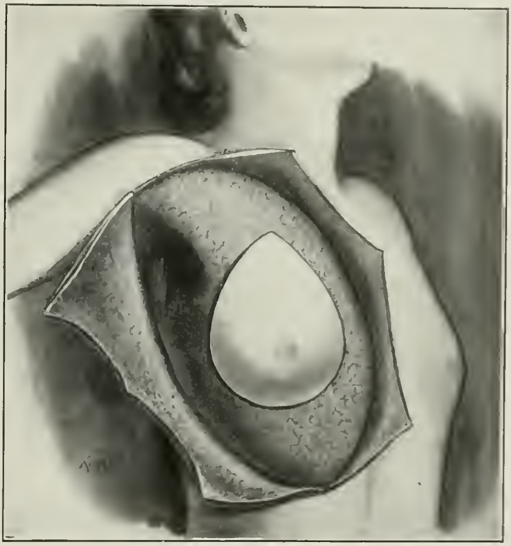

FIG. 397.—This Illustration Shows a Wide Exposure of the Fascia. Extensive removal of the deep fascia is an important feature of the complete operation for carcinoma of the breast. (Original.)

There is sometimes a question as to whether an operation is advisable when the prognosis, as regards ultimate recovery, is practically hopeless; but even in such cases a radical operation usually gives immediate relief, which may last for a number of years; in some instances, indeed, life may be prolonged many years. To the surgical genius of Dr. W. S. Halsted, of the Johns Hopkins Hospital, humanity is indebted for his cultivation of improved diagnostic methods in the early stages of breast cancer and for his insistence on immediate recourse to an operative procedure combining facility and thoroughness in execution with avoidance of essential mutilation.* This demonstra-

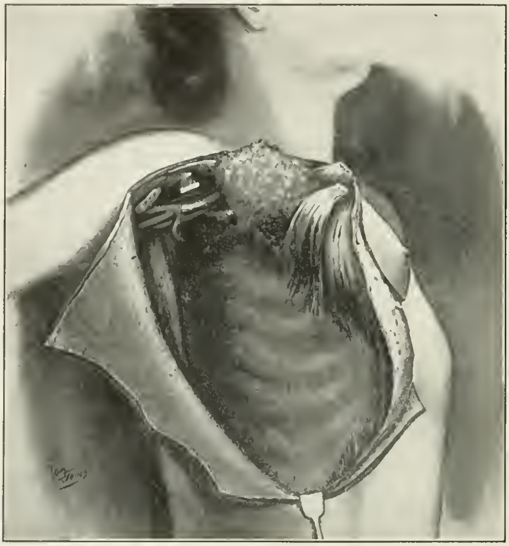

Fig. 398.—In this Illustration the Mass, Composed of the Breast, the Axillary Contents, and the Pectoral Muscles, is rolled inward just prior to the separation of the pectoralis major muscle from the thoracic wall. (Original.)

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*The following extracts from Halsted's article in the Johns Hopkins Hospital Reports (vol. iv., No. 6, Baltimore, 1894) furnish fairly full information with regard to the technique of his method of operating. The thirteen full-page plates which accompany the article add largely to its instructive value, but, unfortunately, it is not practicable to reproduce more than two of them here.

"(1) The skin incision is carried at once and everywhere through the fat.

"(2) The triangular flap of skin (Fig. 100, *a b c*) is reflected back to its base line (*b c*). There is nothing but skin in the flap. The fat which lined it is dissected back to the lower edge of the pectoralis major muscle, where it is continuous with the fat of the axilla.

"(3) The costal insertions of the pectoralis major muscle are severed, and the splitting of the muscle, usually between its clavicular and costal portions, is begun, and continued to a point about opposite the scalenus tubercle on the clavicle.

"(4) At this point the clavicular portion of the pectoralis major muscle and the skin tion of the enormously increased immunity from recurrence after an early and complete operation, with removal of the pectoral muscles, marks an epoch in the surgery of the female breast. Even a single cure, such as that mentioned in the foot-note at the bottom of page 543, should encourage us to make an earnest effort for the relief, by operation, of even those cases which appear most unpromising. There is another class of cases in which the disease is so far advanced as to make it certain that no possible operation will effect the removal of all cancerous tissue, and in which, for this reason, the propriety of operating may be questioned. Nevertheless, even in such a case a radical

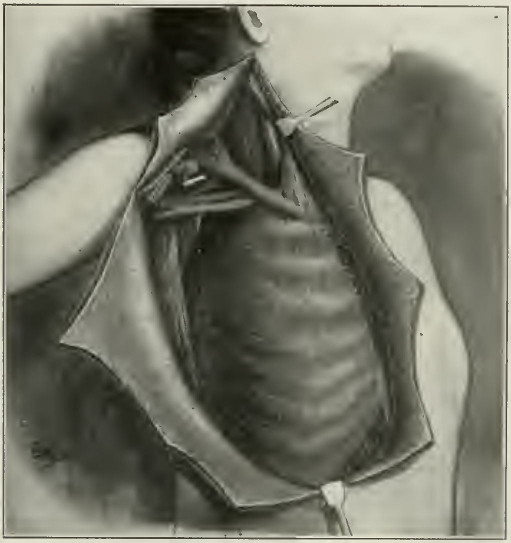

FIG. 399.—The Dissection is here Shown as Completed, including the removal of the lymph nodes, the fat, and the connective tissue of the posterior cervical triangle. (Original.)

overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla.

"(5) The loose tissue under the clavicular portion (the portion usually left behind) of the pectoralis major is carefully dissected from this muscle as the latter is drawn upward by a broad sharp retractor. This tissue is rich in lymphatics, and is sometimes infiltrated with cancer.

"(6) The splitting of the muscle is continued out to the humerus, and the part of the muscle to be removed is now cut through close to its humeral attachment.

"(7) The whole mass, skin, breast, areolar tissue, and fat, circumscribed by the original skin incision, is raised up with some force, to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs and pectoralis minor muscle. It is well to include the delicate sheath of the minor muscle when this is practicable.

"(8) The lower outer border of the minor muscle having been passed and clearly exposed, this muscle is divided at right angles to its fibres and at a point a little below its middle.

"(9) The tissue, more or less rich in lymphatics and often cancerous, over the minor muscle operation offers at least a chance of permanent arrest of the disease locally, and in so far gives hope to the sufferer. Radical operation in such cases may materially lengthen life, and only occasionally shortens it; the patient is often spared the horror of an intractable, offensive, ulcerating tumor, with its attendant

near its coracoid insertion, is divided as far out as possible and then reflected inward in order to liberate or prepare for the reflection upward of this part of the minor muscle.

"(10) The upper, outer portion of the minor muscle is drawn upward with a broad sharp retractor.

. . . .

"(11) The small blood-vessels (chiefly veins) under the minor muscle near its insertion must be separated from the muscle with the greatest care. These are embedded in loose connective tissue which seems to be rich in lymphatics and contains more or less fat. This fat is often infiltrated with cancer. These blood-vessels should be dissected out very clean and immediately ligated close to the axillary vein. The ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off; or the vessels themselves might be torn away by the clamps.

. . . .

"(12) The subclavian vein having been exposed at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers. . . . The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed it is best to push the vein away from the tissues rather than, holding the vein, to push the tissues away from it. It may not always be necessary to expose the artery, but I think that it is well to do this, for sometimes, not usually, the tissue above the large vessels is infiltrated. And we should not trust our eyes and fingers to decide this point. It is best to err on the safe side and to remove in all cases the loose tissue above the vessels and about the axillary plexus of nerves.

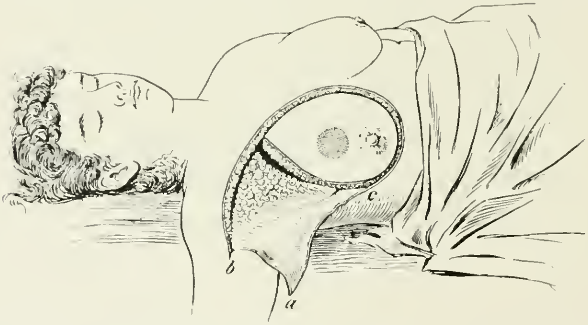

FIG. 400.—First Stage of the Halsted Operation. (From Dr. W. S. Halsted's article in the Johns Hopkins Hospital Reports.) The diagram shows the skin incisions, the triangular flap of skin, *a b c*, and the triangular flap of fat.

"(13) Having cleaned the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla—the lateral wall of the thorax. We must grasp the mass to be removed firmly with the left hand and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus muscle.

"(14) When we have reached the junction of the posterior and lateral walls of the axilla, or a little sooner, an assistant takes hold of the triangular flap of skin and draws it outward, to mental distress, the terrible neuralgia following the involvement of the brachial plexus, and the painful swelling of the arm due to extensive involvement of the axillary vein and the lymphatics. (Fig. 402.) In such cases,

assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi muscles. The operator having taken a different hold of the tumor, cleans from within outward the posterior wall of the axilla. Proceeding in this way, we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed, at the discretion of the operator. Kuster lays great stress upon the importance of these nerves for the subsequent usefulness of the arm. We have not as yet decided this point to our entire satisfaction, but I think that they may often be spared to the patient with safety.

"(15) Having passed these nerves, the operator has only to turn the mass back into its natural position and to sever its connection with the body of the patient by a stroke of the knife from *b* to *c*, repeating the first cut through the skin.

"All that has been removed is in one piece. (Fig. 401.) There are no small pieces nor shreds of tissue. I believe that we should never cut through cancerous tissues, when operating, if it is possible to avoid doing so. The wound might become infected with cancer either by the knife which has passed through diseased tissue and perhaps carries everywhere the cancer-producing agents, or by the simple liberation of the cancer cells from their alveoli or from the lymphatic vessels. The division of one lymphatic vessel and the liberation of one cell may be enough to start a new cancer.

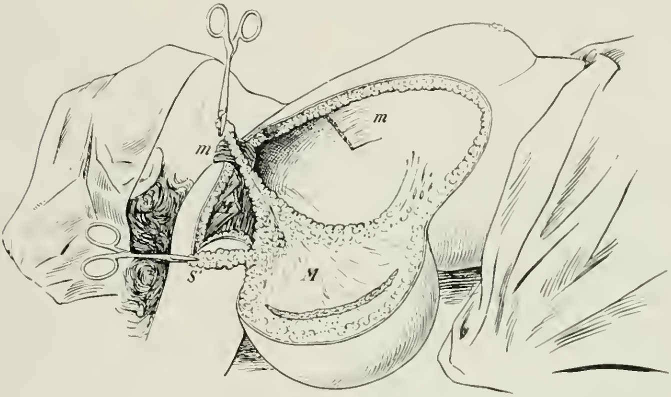

Fig. 401.—A Later Stage of the Halsted Operation. The illustration shows the mamma, the connective tissue, etc., separated from the thorax and ready to be removed in a single mass. *M*, pectoralis major muscle; *m*, *m*, pectoralis minor muscle; *S'*, apex of fat above the subclavian vessels. (From Dr. W. S. Halsted's article in the Johns Hopkins Hospital Reports.)

. . . .

"The operation, as we perform it, is literally an almost bloodless one.

. . . .

"The edges of the wound are approximated by a buried, purse-string suture of strong silk. Of the triangular flap of skin (*a b c*) only the base is included in this suture. The rest of this flap is consequently shifted to a new and lower position. The axilla is never drained and invariably heals by first intention. The uncovered wound often heals by the so-called organization of the blood-clot."

again, the most complete operation possible is the most humane and proper, in that it offers the only chance of permanent local relief, and may not improbably be followed by a considerable interval of comfort. In a desperate case of unbearable pain from extensive involvement of the nerves, section of the posterior roots of the spinal nerves involved may afford relief from pain so long as the patient lives; or interscapulo-thoracic amputation may be justifiable, to give relief from agonizing pain and possibly even to prolong life. Patients in whom the spinal cord is involved, and who suffer from paraplegia dolorosa, so graphically described by Osler, may be relieved of unendurable pain by a division of the spinal cord above the lesion, as suggested by Cushing. Finally, there are cases of slow dying from the effects of a deep, painful metastasis, in which no surgical procedure is possible. In these cases, morphine, chloroform, or any available analgesic should be employed, for the purpose of mitigating unbearable suffering.

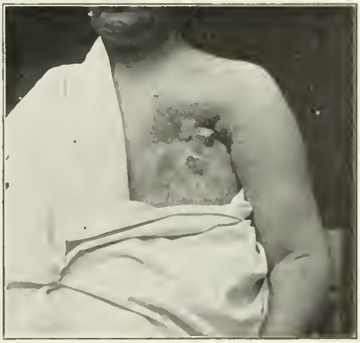

Fig. 102. Extensive Recurrence of Carcinoma of the Female Breast, Associated with Œdema of the Arm of the Same Side. (From St. Louis Skin and Cancer Hospital.)

Results of Operative Removal of Cancer of the Breast.

Carcinoma of the breast, if not operated upon, ordinarily results fatally in from eighteen to thirty months. Certain very malignant forms of the disease cause death even within a few weeks, while some slow-growing cancers, in women of advanced age, may go on for twenty years or more. Patients operated on, but in whom the disease reappears before the end of the three-year limit of Volkmann, are said to live, on the average, nearly a year longer than those upon whom no operation is performed. The operative mortality has within the past twenty-five years been reduced from about twenty-three per cent to less than two per cent at the hands of the best operators.

The results of operation, in individual cases, depend largely on the pathological variety of the tumor. Halsted's statistics, based on two hundred and ten traced cases of cancer operated on more than three years previously, show 42.3 per cent of cures (on the basis of the three-year limit). The adeno-carcinomata give the most favorable showing, viz., 75 per cent of cures; while scirrhous cancer, of which the number of cases is greatest, gives only 35.5 per cent of cures. The results of operation in medullary cancer are very much less favorable than in scirrhus. While end results turn largely on the radical removal of all suspected tissue, Kocher's statement—"that the determining factor for the operative prognosis is the *time* and not the *manner* of operation" —probably holds true. In scirrhus, particularly, the disease may be active and metastasis may occur long before a visible or palpable tumor is developed. Even incomplete operations in recent cases yield better results than extensive operations in advanced cases.

Cheyne reports over fifty per cent of cures for three years or more after operation. Although the greater number of local recurrences appear early (from forty per cent to sixty per cent during the first six months), it is certain that the three-year limit is too short to allow us to class cases as cured. Local recurrence is rare after the first year, but may occur after a lapse of several years. With earlier recognition of cancerous tumors, a more general appreciation of the importance of removing the growth at the earliest possible moment, and the more frequent and earlier performance of the radical, complete operation, we may look forward to better results. With a more general adoption by surgeons of the practice of a thoroughgoing removal of the deep fasciæ in the entire operative field, we may hope for a still larger percentage of cures in the future.

OTHER METHODS OF TREATMENT IN CASES OF CANCER OF THE BREAST.

Oöphorectomy.—Double oöphorectomy has been tried to some extent in cases of recurrent and inoperable cancer of the breast. (Fig. 403.) It is questionable whether there have been any positive cures resulting from this procedure, although a number of cases have been reported as benefited. Mr. Hugh Lett reports 36.4 per cent of his cases as materially benefited. In the more successful cases great benefit is claimed, as shown in relief from pain, marked improvement in health, general diminution or even apparent disappearance of the growth, healing of ulceration, and prolongation of life. Mr. Lett claims that the favorable age for this procedure is between forty-five and fifty years; that after fifty it is seldom worth doing. The value of this procedure is doubtful.

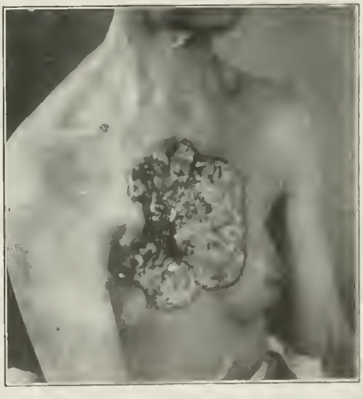

FIG. 403. Inoperable Carcinoma of the Right Breast. (From St. Louis Skin and Cancer Hospital.)

Roentgen Rays.—Exposure to the Roentgen rays has been extensively tried in the treatment of cancer, and is credited with an undetermined percentage of cures. In cancer of the breast it should never be allowed to delay operative procedure when this is possible. In inoperable, advanced, or recurrent cases (Fig. 404) the use of the Roentgen rays frequently gives relief from pain, and, in a limited number of cases, appears to retard or arrest the cancerous process.

Malignant Papillary Dermatitis (Paget's Disease).—Paget's description of this unique affection is as follows:—"In all [cases] the disease began as an eruption on the nipple and areola. In the majority it has the appearance of a florid, intensely red, raw surface, very finely granular, as if nearly the whole thickness of the epidermis were removed, like the surface of a very acute diffuse eczema, or like that of an acute balanitis. From such a surface on the whole or greater part of the nipple and areola, there was always copious, clear yellowish, viscid exudation. The sensations were commonly tingling, itching, and burning, but the malady was never attended by disturbance of the general health.

"It has happened that in every case which I have been able to watch cancer has followed within at the most two years, and usually within one year. The eruption has resisted all the treatment, both local and general, that has been used, and has continued even after the affected part of the skin has been involved in the cancerous disease. The formation of cancer has not in any case taken place first in the diseased part of the skin. It has always been in the substance of the mammary gland beneath or not far from the diseased skin, and always with a clear interval of apparently healthy tissue."

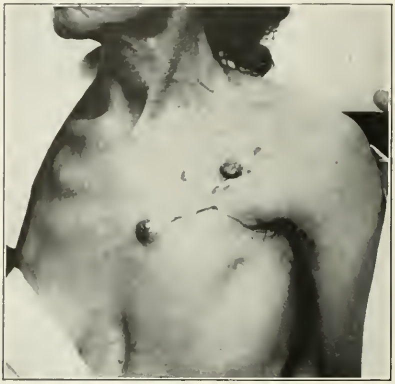

Fig. 404.—Recurrence of the Disease in the Scar Resulting from an Operation Performed at an earlier date for the Removal of a Carcinoma of the Left Breast. (From St. Louis Skin and Cancer Hospital.)

Matzenauer, Karg, Benjamin, and Ehrhardt regard Paget's disease as a primary carcinoma of the skin. Jacobæus also believes that it is carcinomatous from the beginning. Thin believes that it consists primarily in a slowly advancing cancerous process about the mouths of the lactiferous ducts, which at a very early stage leads to irritation in the superficial tissues of the nipple and areola (Fig. 405), and eventually extends to the substance of the mammary gland. He believes that the cancerous changes are definitely established in the ducts long before they give rise to sufficient induration to produce a palpable tumor. The disease differs essentially from simple chronic eczema of the nipple and areola, in that it is distinctively a degenerative process ending in ulceration. Neither does it present the characteristic picture of epithelioma. According to Schultze, no authentic case has been reported of epithelioma growing from the epidermis of the nipple and areola on a basis of Paget's disease, or from the growths involving the breast.

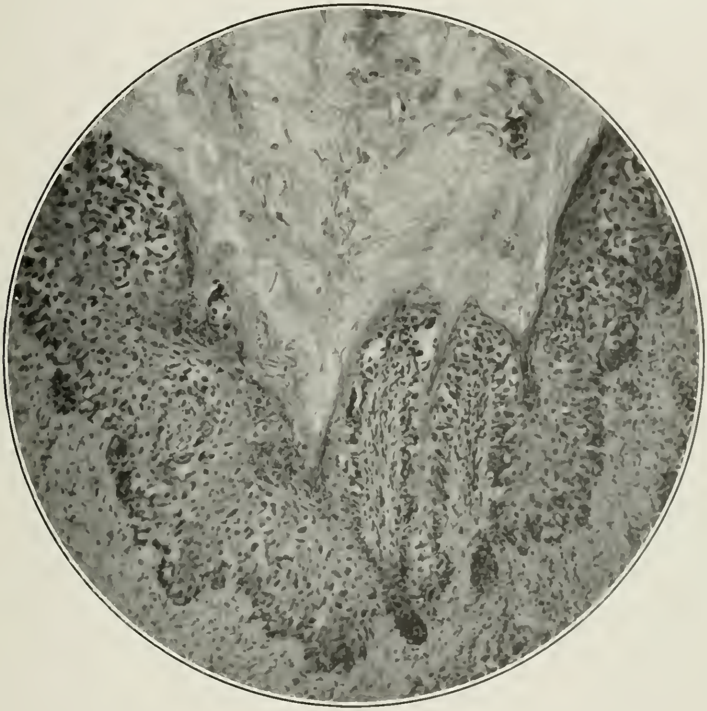

Fig. 405. Paget's Disease of the Nipple. (After Dr. John A. Fordyce. *Journal of the American Medical Association*, 1908.)

The microphotograph (Spencer $\frac{1}{6}$ in., Zeiss Comp. oc. 4) shows marked hyperkeratosis, acanthosis and vacuolization of the prickle cells. In the corium there is an infiltration of lymphocytes and plasma cells.

The etiology of Paget's disease is undetermined: the causative relation of the psorosperms described by Darier, Wickham, and others, and of the vegetable fungus, of the nature of a yeast, found in the diseased skin and axillary lymph nodes by Fabry and others, is at least doubtful. The disease occurs usually in women between forty and sixty years of age.

Treatment.—This should be the early and complete removal of the breast.

including all diseased tissue. The removal of only the nipple, areola, and underlying parts of the breast would at best leave a useless remnant of the organ without outlet for secretion. The ever-present danger of leaving portions of affected tissue behind, and the safety of complete extirpation, make this clearly the operation of choice. Should any palpable tumor be present, the axilla should be carefully cleared, as in the radical operation for carcinoma of the breast. Cases of cure by the Roentgen rays have been reported, but prompt and complete extirpation is unquestionably the safest procedure.

SURGICAL DISEASES AND WOUNDS OF THE EXTERNAL GENITALS AND VAGINA OF THE FEMALE.

By WILLIAM P. GRAVES, M.D., Boston, Massachusetts.

I. DISEASES DUE TO INFLAMMATION OR TO CIRCULATORY DISTURBANCES.

Gonorrhœa of the External Genitals.—The gonococcus has a peculiarly selective action on the female genital organs, affecting the urethra, Skene's glands, Bartholin's glands, and the cervical mucous membrane. So constant is this occurrence that a local acute inflammation in any one of these parts may usually be attributed to the gonococcus. The vulva, vagina, and endometrium are but rarely affected primarily, and only in severe or neglected cases secondarily.

Gonorrhœal Urethritis.—The urethra is usually the primary seat of a gonococcal infection. As a rule, the attack is signalized by sharp scalding pain on urination two or three days after coitus. There is soon established a purulent discharge which may be so slight as to escape the attention of the patient; or it may be profuse. Gonorrhœal urethritis in women does not run the definite course that it does in men. It may be so mild that symptoms disappear spontaneously in from five days to a week, or it may become chronic and persist until long after other evidences of the disease have entirely disappeared. As a rule, the course of urethritis is mild, and many women suffering from the later developments of gonorrhœa have passed through the initial urethritis stage without knowing it.

The treatment of urethritis is important, as one may, by an early attack on the disease, prevent it from extending to the cervix and the Fallopian tubes. Before the treatment is begun, however, the diagnosis should first be confirmed by the microscopic examination of a smear from the urethral discharge.

The most effective method of treatment is by the use of protargol. Frequent urethral injections of a solution of this substance, five or ten per cent strength, will as a rule quickly control an attack of urethritis. The patient should be kept quiet, and salol or sandalwood oil should be given by the mouth four times daily. In order to prevent the disease from extending to the internal pelvic organs it is well to prescribe at least four hot douches daily. A solution of potassium permanganate (one drachm of the concentrated solution to a quart of hot water) is the best to use for the douches. If this solution proves to be too irritating, simple sterile water may be used in alternation with it. Two or three times each week the surgeon will do well thoroughly to swab the vagina with some efficient antiseptic and then to insert a tampon soaked in a twenty-per-cent solution of protargol in glycerin. This tampon should not be allowed to remain in the vagina longer than twenty-four hours. The treatment suggested should be maintained until the urethral discharge disappears. Stricture of the female urethra is a very rare result of gonorrhœal infection. As a rule, it yields readily to instrumental dilatation.

Inflammation of Skene's Glands.—A frequent complication of a specific urethritis is the infection of Skene's glands. The glands become swollen and red and bathed in yellow pus. Pus can be seen exuding from their small orifices. Such an appearance is practically pathognomonic of gonorrhœa. Pain on micturition is severe and the parts are decidedly tender. On account of the inaccessibility of the seat of inflammation this condition persists for a considerable period and is little affected by douching and urethral injections. One method of treatment is to lay the glands open from their orifices and to cauterize the open surfaces with a silver-nitrate pencil. Another effective method is to inject a protargol solution (ten per cent to twenty per cent) into the orifices by means of an ordinary hypodermic syringe, the point of the needle being first blunted.

Inflammation of Bartholin's Glands.—Bartholin's glands are particularly liable to infection, especially in neglected cases of gonorrhœa. Like the similar affection of Skene's glands an acute inflammation of these glands is practically pathognomonic of gonorrhœa. A painful ovoid swelling usually appears at the seat of one of the glands. The pain is severe. In most cases the swelling eventuates in the formation of an abscess, the result of an early invasion of infective organisms. The pus may escape through the canal of the gland, or the abscess may require surgical intervention.

The treatment should always be radical excision of the gland. Palliative measures may temporarily cure the symptoms and even cause the swelling to disappear entirely. Acute exacerbations, however, are the rule, the glands finally becoming cystic, as explained on page 566. The septic gland should be removed through an incision made in the labium minus at a point as far to the outside of the focus of infection as possible. If the abscess is removed *in toto* the wound may be closed and will usually heal by first intention. If the wound is infected it should not be entirely closed, but should be left open at the lower extremity for the introduction of a small drain. If the abscess is very large the pus should first be evacuated and appropriate treatment carried out for a certain length of time before the radical operation is performed. In this way the necessity of dissecting out an abnormally large abscess cavity may be avoided.

Vaginitis.—In adult women the vagina is rarely infected by gonorrhœa primarily. It may become secondarily affected in neglected cases, in which event it takes part in a general mixed infection of all the external genitals. As a rule, the condition yields readily to cleansing treatment. Copious douching with hot permanganate solution every three hours, occasional swabbing of the vagina, and insertion of protargol or ichthyol tampons constitute the routine treatment.

In young girls vaginitis of gonorrhœal origin is much more difficult to treat successfully. It is always accompanied by vulvitis. The more tender and succulent character of the vaginal epithelium in young subjects favors the growth of the gonococci. Douches, as a rule, cannot be employed. Unremitting cleanliness, as regards the external parts, and—when possible—injections of protargol into the vagina with a glass syringe, are the most effective means at hand.

Endocervicitis.—One of the most intractable sequelæ of gonorrhœa in women is the chronic inflammation of the cervical mucous membrane—an affection which may last for months or even years. The infection, which is a mixed one, has its seat in the arborescent cervical glands. An examination of these parts with the microscope shows that the glands are swollen and cystic, and that they contain mucus, cell detritus, and pus. There exudes from the os a muco-purulent fluid which causes an incessant and annoying leucorrhœa. Excepting in the early stages gonococci cannot be demonstrated in the cervical discharge. This condition, which may persist for a long time after other evidences of the disease have disappeared, is most difficult to treat. Local treatment with tampons and douches exerts only a temporary effect. Curettage under ether causes only a brief cessation of the discharge. A more effective method of treatment is to dilate the cervix thoroughly and then, by means of the actual cautery, to burn several deep longitudinal furrows in the cervical canal. The most successful office treatment consists in scarifying the canal deeply with a small sharp-pointed nasal curette and immediately afterward applying some strong astringent preparation—as, for example, a solution of silver nitrate, iodized phenol, or Churchill's tincture of iodine. This plan of treatment, which gives the patient little or no pain, should be repeated two or three times each week.

In severe cases, where the stroma of the cervix is much hypertrophied and the glands have undergone cystic degeneration, it is necessary to resort to a surgical removal of the entire cervical mucous membrane. This may be accomplished by Schroeder's operation, which is described on page 593.

Pruritus Vulvæ.—Pruritus vulvæ, or vulvitis pruriginosa, is a disease which occurs mostly in old age. It is characterized by an intense burning or itching of the external genitals, usually most severe at night, and is one of the most distressing affections from which women suffer. The disease is attended with a change in the epidermis of the external genitals which may be confined to the neighborhood of the clitoris or may extend over the entire vulva. The skin takes on a pale, dead-white appearance, is leathery and swollen, and contains small fissures or superficial excoriations caused by scratching. In advanced cases the natural folds of the vulva may be completely obliterated, the labia minora merging without any distinguishable boundary line into the labia majora, while the clitoris may appear only as a small dimple.

Under the microscope the epidermis shows the so-called "inflammatory parakeratitis." There is a deep infiltration of the connective tissue of the corium with small round cells. The epidermis is much thickened and the horny layers are very irregular.

The etiology of this disease is a matter of considerable debate among investigators, many considering pruritus an essential disease, while others regard it only as symptomatic of some underlying affection. Veit calls attention to the fact that, in the majority of cases, it is possible to discover some exciting cause which, by its mechanical or chemical effect on the skin, gives rise to the distressing itching. The constant scratching which is evoked by the itching produces the chronic inflammation of the epidermis which has been described. The endings of the nerve filaments of the skin thus suffer a continuous irritation. The mechanical causes which set up this chain of pathological changes are chiefly excessive coitus and masturbation. The chemical causes are abnormal secretions or excretions which may bathe the external genital parts. Most important of these is the urine of diabetes mellitus, which, on account of the frequent and copious micturition, keeps the parts in a continual state of moisture and in addition exerts an unusually severe irritating effect through its chemical composition. Other causes are irritating secretions dependent upon any form of vaginitis or cervicitis. The discharge from carcinoma of the uterus frequently causes pruritus, as does also the discharge set up by an ill-fitting or neglected pessary. A vegetable parasite, the so-called "soor fungus," is sometimes met with as a cause among uncleanly persons, especially during pregnancy. In some cases no underlying cause can be discovered; and yet, even in these cases, an adequate cause may be discovered at some later date, as happened, for example, in a case reported by Kelly, in which a small sloughing fibroid was found in the canal of the uterus.

The treatment of pruritus consists primarily in the treatment of its underlying cause, and in this way many apparently intractable cases may be successfully treated. For the immediate relief of the itching the application of a weak solution of carbolic acid in dilute alcohol may be used; hot sitz baths may also be prescribed. A lotion made up of gum tragacanth and glycerin, one-half ounce of each; alcohol and cologne, four ounces of each; and one quart of water—applied four or five times daily and rubbed well into the parts—has been found by the writer to be of much value. In cases where the disease has been of such long standing that no efforts can restore the skin to anything like a normal condition, excision of the affected area (especially if it have well-defined limits) is indicated. Where it is necessary to remove large areas the parts may be excised down to the vaginal opening, leaving the tissue about the urethra so as not to distort the direction of the canal. These wounds can be readily closed without too great tension on the skin. Silkworm-gut sutures should be used, and they should be placed in such a manner as to secure good coaptation with avoidance of dead spaces. Buried sutures should be avoided as far as possible.

Kraurosis Vulvæ.—Kraurosis (from a Greek word signifying to wither) is a disease of the vulva which is closely identified with pruritus, and is thought by many to be the end result of that condition. (Fig. 406.) It is characterized by an atrophy and disappearance of the clitoris and labia minora and majora, and by a shrinking and contraction of the vaginal entrance. The external skin is white, dry, stiff, and friable, the epidermis being thick and rough. The subcutaneous fat disappears and the tissues of the labia and vaginal entrance are lacking in their normal elasticity.

Examined under the microscope the subcutaneous connective tissue appears to be hypertrophied and to have the homogeneous aspect of scar tissue. The papillæ are flattened and the Malpighian layer is thin. Sebaceous follicles and sweat glands are scanty or completely absent. All evidences of pigmentation seem to have disappeared. Peter describes the lesion as "chronic inflammatory hyperplasia of the connective tissue, with a tendency to cicatricial atrophy and a degeneration of the elastic tissue."

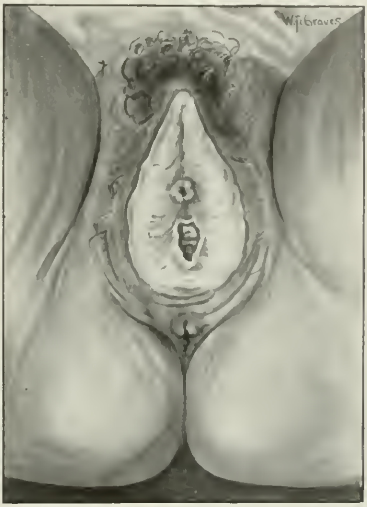

FIG. 406.—Kraurosis Vulvæ. The clitoris and labia minora have disappeared. The vulva is white and creased. The vagina is atrophied and stiff at the introitus. (Original.)

The etiology of this disease is obscure, and it is uncertain whether it is to be differentiated from the advanced stages of pruritus, or not. The diagnosis between the two conditions is sometimes impossible. It is said that the line of demarcation between the area of kraurosis and the surrounding healthy skin is much sharper than in pruritus, and that kraurosis invariably involves the entire vulva, whereas pruritus more commonly is confined to an area of relatively narrow limits.

The symptoms of kraurosis are pain, burning, and itching. The patient also complains frequently of a contracted vagina, and of a tight, stretching feeling while walking. The disease does not yield to palliative measures, as is frequently the case in pruritus, and the treatment should generally be operative. The operation consists in a systematic excision of the affected parts, and should be performed according to the principles laid down for the operation for pruritus.

Elephantiasis.—Elephantiasis is a term which is applied to a coarse, brawny hypertrophy of the external genitals. It may affect either the clitoris, the labia majora, or the labia minora, or it may involve all of them together. Like ulcus rodens its etiology is obscure. It occurs usually in prostitutes, many of whom have had syphilis or bubo. It is characterized by a tumor-like conversion of the different parts of the vulva, which in general retain their characteristic contour. Gebhard describes three forms—elephantiasis glabra, elephantiasis tuberosa, and elephantiasis condylomatosa. In elephantiasis glabra the surface of the epithelium is smooth and resembles the epithelium of other parts; in elephantiasis tuberosa the surface is covered with nodules or deep furrows, the epithelial covering, however, remaining unchanged; and in elephantiasis condylomatosa the surface is covered with warty excrescences. Miscroscopically, there is seen to be an excessive growth of subepithelial connective tissue. This tissue is poor in cells, has few vessels, and is very œdematous. The epithelial covering is thinner than normal. Ulceration may occur, in which case there is a close resemblance to ulcus rodens or to carcinoma.

The treatment is operative, and consists in a radical removal of the hypertrophied parts. In these cases there is special danger of sepsis in operating, and great care should be taken to make a clean dissection, to control perfectly all bleeding, and to secure good approximation of the edges of the wound.

Hypertrophic Ulceration of the Vulva, or Ulcus Rodens. Hypertrophic ulceration of the vulva is a term adopted by Huguier to describe a condition named by Virchow ulcus vulvæ rodens, and more recently, by the French, esthiomène. It was formerly thought to be tuberculous in origin, and was commonly called lupus vulvæ. Although closely associated with elephantiasis and considered by many as simply an ulcerated form of that disease, the best authorities classify it as a distinct affection. Hypertrophic ulceration, or ulcus rodens, is characterized by an extensive ulceration of the surfaces of the vulva. This is attended with a stiff, hard œdema of the labia, hymen, and prepuce. The surfaces are bathed with a whitish irritating discharge. The ulcerations have clean edges. The contours of the ulcerated surfaces frequently correspond to the contour of the inner surface of the lips. The bases of the ulcerations show sluggish granulations which manifest no marked tendency to slough. The process advances slowly and is very resistant to healing measures.

Etiology.—The etiology of the disease is extremely obscure. It occurs nearly always in prostitutes or in women who have been prostitutes. Some consider it the result of chronic trauma and infection. In a number of instances this form of ulceration of the vulva has followed the removal of diseased lymph nodes in the groin, and for that reason it has been thought by some to be the result of a passive congestion of the lymph circulation. Many have considered it a form of tertiary syphilis. Potassium iodide in long-continued treatment, however, has no effect upon the affection. Tubercle bacilli cannot be demonstrated in it microscopically.

Diagnosis.—As regards the question of diagnosis it is chiefly important to distinguish the disease from cancer, which in some respects it may resemble. The absence of involvement of the lymph nodes, the scattered location of the ulcers, and the microscopical examination of an excised specimen should suffice to distinguish ulcus rodens from cancer.

Symptoms.—As a rule, the condition is not especially painful until a considerable area is involved. When this condition is reached the foul, unclean discharges become a source of great discomfort and distress. Cleanliness is difficult to attain and the victim of the disease becomes physically and mentally a pitiful object.

Treatment.—In some cases drastic treatment of the ulcers with strong acids will result in a slow cure. In advanced cases palliative treatment is entirely without avail, and a radical excision of the diseased tissue should be resorted to.

The technique of the operation is similar to that employed in cancer, though the incision may be made closer to the diseased areas.

Tuberculosis.—Tuberculosis of the external genitals was formerly thought to be common, but as a matter of fact it is a rare disease. It consists of a localized ulcerating area, more commonly situated in the vestibule. Diagnosis is made by the microscope. The treatment is complete excision.

Soft Chancre.—Soft chancres of the female genitals are usually multiple. They occur most commonly on the frænulum and on the labia majora. They may extend out on the thighs and around the anus. At the frænulum the ulcers may become confluent and cause a deep fissure. The ulcers are circular, with sharply defined edges and a base covered with thick pus. There is very little infiltration in the surrounding tissue. As a rule, they are not very tender, though in some cases they may be exquisitely so. The inguinal lymph nodes are early affected, and a bubo is usually present on one or both sides.

Treatment.—The most efficient method of treating soft chancres is to touch them with fuming nitric acid, and immediately afterward with alcohol and corrosive sublimate. As a final step, the parts should be mopped gently with sterile water. Most women are willing to undergo the intense pain which this treatment momentarily gives them for the sake of the prompt relief which it insures.

Hard Chancre.—The primary syphilitic lesion of the female genitals is not very frequently seen. It occurs as a small, circumscribed, hard infiltration, usually on the labia minora. It may later become ulcerated. When the chancre is situated on one of the labia majora the lips become stiff and œdematous, and assume a somewhat characteristic brownish-red color.

Syphilitic Condylomata.—These appear as secondary manifestations of the disease. They are broad elevations with moist surfaces. They have a strong tendency to irregular ulceration. They are usually multiple and are apt to have a symmetrical distribution, due to auto-infection through contact of opposing surfaces. They are extremely infectious, and are the principal means of conveying the disease.

II. TUMORS OF THE EXTERNAL GENITALS.

Cysts of Bartholin's Glands.—The most common cysts of the vulva are retention cysts following an old gonorrhœal infection of Bartholin's glands. As has been shown by Huguier and Pozzi, the cysts, like the abscesses of Bartholin's glands, usually involve only the duct of the gland. (Fig. 407.) Most commonly the cysts contain an opaque fluid made up of detritus, leucocytes, and cholesterin crystals. They may rest quiescent and painless for a long time, and then occasionally light up into active abscesses. In other cases the inflammatory process may come absolutely to a standstill, the contents of the cyst becoming a clear serous fluid and the whole cyst growing more and more distended and thinner. Cases of the latter character are not infrequently the result of a gonorrheal infection incurred in childhood. In middle-aged or elderly women one sometimes encounters neglected cysts of Bartholin's glands which may increase to a very considerable size, and thus closely resemble a labial hernia. The differential diagnosis is quite readily made by the absence of the characteristic manifestations of the latter condition.

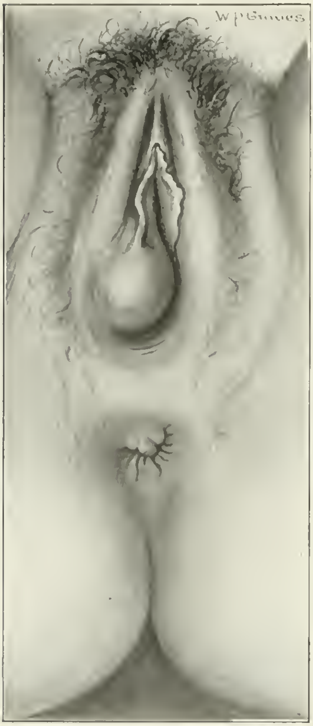

Fig. 407. Cyst of Bartholin's Gland. (Original.)

These cysts produce ordinarily no symptoms except such as are due to their bulk. Thus, they may interfere with coitus or with the free voiding of urine. They are apt, however, at more or less regular intervals, to become inflamed and to cause pain.

Radical extirpation is the only effective treatment. It is often possible to dissect out these cysts in their entirety, and this may be done even when the cyst is in a state of active inflammation. If, in the course of the operation, the cyst should be broken and its infectious contents should escape into the surrounding tissues, the wound should be thoroughly irrigated, first with an antiseptic solution and then with sterile water, and the surfaces should be carefully wiped dry. The closure of the cavity left by the removal of the cyst should be effected in such a manner that all subcutaneous bleeding shall be prevented and that no dead spaces shall remain. This can usually be accomplished by the deep placing of silkworm-gut sutures. The burying of catgut sutures is to be avoided; most of the bleeding can be controlled by the silkworm-gut sutures. But if it be found necessary to tie bleeding points, fine catgut may be used for the purpose. Such wounds, if well cared for during convalescence, usually heal by first intention. In order to secure this result it is best to make the incision, outside the labium minus, through the thick skin. Such a wound is much less liable to infection than one made through the moist modified skin on the inner side of the labium minus.

In dissecting out the large cysts great care should be exercised not to injure the urethra or the clitoris. The wall of the cyst presses closely against the urethral canal, and in some cases pushes it away from its normal direction. In the course of the necessary dissection one is liable to lose sight of the exact location of the urethra and may thus easily mutilate the canal, with consequent disagreeable results. In order to obviate this danger it is best first to dissect the cyst cleanly away from the urethra and clitoris. The rest of the dissection can then be carried on rapidly and without fear of injuring any important organ.

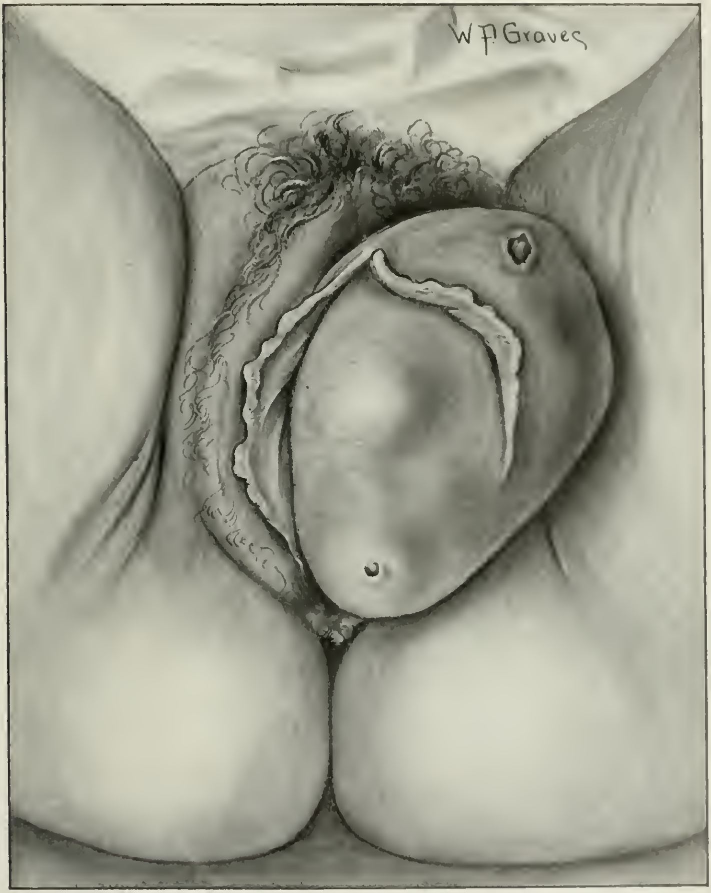

FIG. 408.—Cyst of Bartholin's Gland in an Elderly Woman. The vulva is distorted and the cyst presses on the urethra to such a degree as to interfere with urination. (Original.)

Other Cysts of the Vulva.—Less common cysts of the vulva are the cysts of the body of Bartholin's gland. These are smaller and more deeply situated than those of the duct, and yet, notwithstanding their small size, they may sometimes give much annoyance and pain. Cysts in the labia higher up toward the vagina are probably retention cysts of Gaertner's duct. Cysts of the labia minora and cysts of the hymen are probably retention cysts of the sebaceous glands, these glands having been demonstrated both in the hymen and in the labia minora. Cysts of the clitoris have also been described.

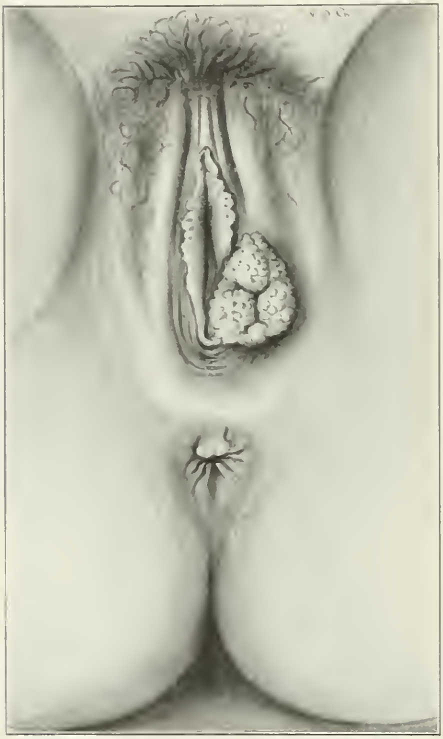

Fig. 409.—Condylomata Acuminata. Original.

Hydrocele of the Round Ligaments.—Hydrocele of the round ligaments may occur in the labia majora. All these cysts, though of no great clinical significance, should be treated by surgical means, as they may cause pruritus or may hinder the free flow of urine or interfere with coitus.

Condylomata Acuminata.—Condylomata are usually a sequence of gonorrhœal infection, although it is said by Gebhard that they may follow other forms of inflammation. They appear in the form of small, pointed, warty growths which are seated upon the skin of the labia majora or minora or on adjacent surfaces of the thigh or buttock. (Fig. 409.) They occur in one or more groups which may eventually become confluent and may cover the entire vulva. Usually they present the appearance of vegetative masses which are moist but do not tend to ulcerate. Their growth is most marked and most rapid in pregnant women. They are seldom painful and do not extend deeply into the tissues.

Examined microscopically the condyloma is found to consist of an hypertrophy of the papillæ of the skin which are markedly arborescent. Like all other warty excrescences the papillæ contain, in their centres, a stem of connective tissue and blood-vessels. Condylomata are occasionally mistaken for cancer and the appearances observed under the microscope are often at first sight confusing, on account of the markedly arborescent nature of the papillary growth. Close examination, however, will always enable one to differentiate the two conditions with little trouble. In condylomata the epithelial masses always contain, in the centre, a connective-tissue core, while in carcinoma the epithelial masses have no such core, but are surrounded by connective tissue. The absence of epithelial pearls in condylomata is also a distinctive point which aids in the diagnosis. In condylomata, furthermore, there is no tendency of the epithelial masses to grow downward into the subcutaneous tissue.

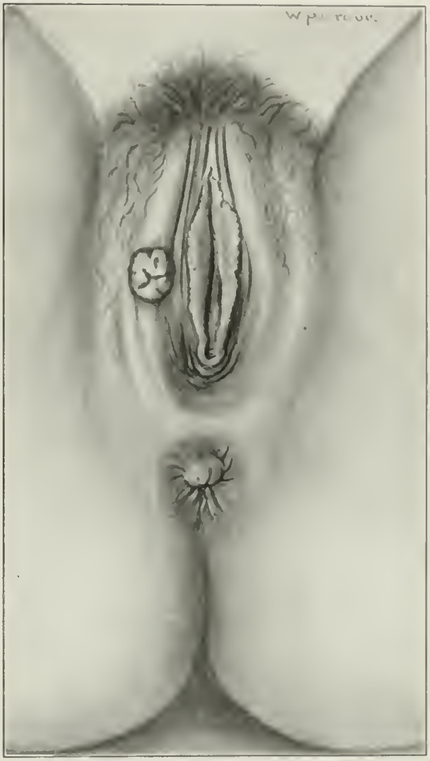

Fig. 410.—Carcinoma of the Right Labium Majus. (Original.)

The proper treatment of condylomata is removal by excision under aseptic precautions, and closure of the wound by either silkworm-gut or fine catgut sutures. These vegetations are often extremely superficial and may frequently be scraped off with a curette without causing more pain than does a superficial abrasion of the skin.

Carcinoma of the Vulva.—The vulva possesses a certain immunity to malignant tumors just as it does to infections, and of all the female genital organs it is the least susceptible to cancer. Carcinoma of the vulva, when it does occur, appears usually in elderly women, most commonly over forty-five years of age. The disease may start in any part of the vulva, but, in the great majority of cases, it develops from one of the labia majora. In its early stage the disease usually presents the appearance of a small round or ovoid tumor, well defined, and hard in consistency. (Fig. 410.) The surface may be smooth, but is usually deeply furrowed, and has a tendency to superficial ulceration. Less commonly the disease starts as a diffuse infiltration of the labium, more apparent by the sense of touch than by that of sight. The surface tends to ulcerate superficially. As a rule, the disease does not at first spread locally with rapidity, and may even appear stationary for a considerable length of time. An early involvement of the inguinal lymph nodes is a characteristic though not a constant occurrence, and frequently extensive involvement of these nodes may be seen where the disease has made little local progress in its primary seat. In time, however, the cancer may take on rapid growth, the greater part of the vulva becoming involved in ulceration and the disease showing a tendency to spread toward the periurethral tissue. In other cases the disease burrows deeply; it may even extend into the perivaginal tissue or into the pelvis, while at the same time the external manifestations of the disease remain comparatively insignificant. An interesting phenomenon manifested by cancer in these parts is the occurrence of the contact metastases, at points where the growth in one labium infects the corresponding surface of the other. Instances of this have been reported by Kelly, Gebhard, and others.

Under the microscope the growth is seen to be a squamous-cell carcinoma, not unlike the skin carcinomata observed in other parts of the body. It differs from them, however, in two respects—a strong tendency to the formation of cancroid pearls and an unusual ramification of the alveoli.

In the earlier stages of cancer of the vulva the only symptom is usually pruritus, but, later on in the disease, there may be severe pain. The diagnosis of cancer of the vulva occasionally presents some difficulties. The only two conditions with which it is likely to be confused are ulcus rodens and condylomata acuminata. Ulcus rodens does not involve the lymph nodes, and there are apt to be several distinct ulcerations, whereas in cancer the ulceration is confined to one continuous area. A prompt examination with the microscope ought to settle the difficulty at once. A condyloma may at times bear a similarity of appearance to cancer and the microscopical appearances of the two may also be confusing. The differential diagnosis between these two conditions is described under Condylomata.

For cancer of the vulva the treatment invariably is excision; the general principles involved in the operation being those employed in cancer of the breast. The inguinal lymph nodes should always be dissected out, whether they can be palpated or not. The carcinomatous area should be removed by a dissection which extends well outside the diseased portions, and which should be carried as deeply as necessary, even to the surface of the bone. No matter how extensive the disease may be, every part of it should be removed, even to sacrificing the urethra. The dissection should be carried out in a clean manner, and every effort should be made to secure primary union of the edges of the wound. In ordinary cases an oval incision is made about the tumor, and the edges of the wound are easily approximated by deep silkworm-gut sutures placed so as to obliterate dead spaces in the depth of the wound. Buried sutures should be avoided. In cases where extensive areas have been denuded the various devices of plastic surgery should be resorted to. Drainage is not necessary excepting in the most extensive operations. Special care should be taken to avoid distortion of the urethra.

Adeno-carcinoma of Bartholin's glands has been described. The disease is rare.

Fibroma of the Vulva.—Fibromata may arise either from the large or from the small labia, and rarely from the clitoris; their common seat, however, is in the labia majora. They are isolated, well-defined tumors, with the usual hard, elastic consistency of ordinary fibromata, and in the course of their growth they commonly become pedunculated. They may attain very large proportions, some having been reported that reached down to the knees of the patient. They may become ulcerated and excoriated. Microscopically they resemble the fibromata that are observed in other parts of the body, many of them containing smooth muscle fibres, while some of them are cystic. Interference with the circulation of the part may result in œdema or in a myxomatous condition. Calcification may be present. It has been shown by Saenger that most of these tumors originate from the round ligaments at their terminations in the labia majora. The presence of muscle fibres and cysts—which elements are characteristic of the true fibromata of the round ligament in the pelvis—is thus accounted for. The operation for fibromata is excision and closure of the wound by deep silkworm-gut sutures.

Sarcoma.—Sarcoma of the external female genitals is a rare disease. Growths of this nature usually originate in the labia majora or in the clitoris. The most common type is the melano-sarcoma, and the greater frequency of this particular variety of sarcoma is doubtless due to the comparatively frequent occurrence of pigmented nævi on or near the labia majora. Sarcomatous and myxomatous degeneration of fibromata may take place, though the prognosis in such cases is much better than in cases of essential sarcoma or of melano-sarcoma.

The treatment is thorough extirpation. When one is operating on the external genitals it is always advisable to remove pigmented nævi, on account of the possibility that they may develop later into melano-sarcoma.

Lipoma.—Lipomata of the vulva are rare tumors, and are of little importance. Their usual occurrence is in the labia majora or in the mons veneris. They are like lipomata in other parts of the body, excepting that they have the peculiar characteristic of growing larger during pregnancy and then diminishing during the puerperium. They also swell in size during the catamenia. As they grow slowly larger and are a source of anxiety and sometimes of pain to the patient, they should be removed.

Urethral Caruncle.—Caruncle of the urethra is a small tumor, usually not larger than a pea, which appears at the urethral orifice. It may have a broad base or it may be pedunculated. The surface is usually smooth, glistening, and brilliantly red or purple in color. The typical caruncle is a true tumor and is composed of a loose connective tissue with a superficial covering of squamous epithelium. The connective tissue is usually infiltrated with round cells. Gebhard has observed in these small tumors tubular glands, lined with a high cylindrical epithelium, but the writer has thus far not been able to confirm this discovery. Occasionally a caruncle attains larger proportions and encroaches upon the vestibulum about the meatus to the extent of half an inch or more, presenting the appearance of a group of small caruncular vegetations. This condition may be mistaken for cancer, and, in fact, the microscopical appearance of the superficial epithelium is also suggestive of cancer. The cells, however, retain their normal type and order, and do not show the irregular downward growth into the subepidermal connective tissue which is characteristic of cancer.

Urethral caruncles may be entirely painless and be discovered only by accident, but in many cases they are exquisitely sensitive and give extreme pain and distress on urination or in coitus. They may cause vaginismus. The suffering may be so great as seriously to impair the general health of the patient. These little growths are so painful that it was long supposed that they contained bundles of nerve endings. However, Fritsch and other investigators were unable to demonstrate the presence of nerve endings.

The treatment of caruncle is removal by surgical means. Small growths with a slender pedicle may be cocainized and snipped off with scissors, the bleeding points being touched with silver nitrate. Only the smallest caruncles, however, should be treated by this method. Larger ones should be carefully excised with a knife—if necessary, under full anaesthesia—and the wound should be closed with very fine catgut sutures. These sutures are usually sufficient to control the bleeding.

Prolapsed Urethral Mucous Membrane.—The mucous membrane of the urethra may prolapse partially or completely, and give an appearance closely resembling that of a true caruncle. The condition can usually be differentiated from true caruncle by careful observation of its appearance at the meatus. Microscopically it can be distinguished by the nature of the surface epithelium, which shows the various layers of modified epithelium characteristic of the lining of the urethral canal. This prolapse of the mucous membrane may prove a painful and troublesome affection, though often it gives no symptoms whatever. In cases where the mucous membrane completely prolapses the extruded portion may become strangulated and even necrotic.

The proper treatment, in cases where the condition gives rise to pain or discomfort, is removal by surgical means under appropriate anæsthesia. The removal should be effected by an annular dissection, and the upper and lower surfaces should be united by fine catgut sutures.

Hæmatoma.—Hæmatoma of the external genitals is both an uncommon and a serious condition. It usually appears during pregnancy and is a result of obstruction in the vaginal system of veins. The appearance is of a purple mass of veins at one side of the vaginal introitus. The patient should be kept in bed with the hips elevated, and she should assume the knee-chest position for fifteen minutes three or four times daily. If this does not suffice, in very serious cases, pregnancy may be terminated by Cæsarian section, when the child is viable. In some cases it may appear wise to incise the hæmatoma, and evacuate its contents, but it should be remembered that the operation is attended with danger of infection and should be performed only by an experienced surgeon.

III. ABNORMALITIES OF THE EXTERNAL GENITALS.

Imperforate Hymen.—Atresia of the hymen may be due to a congenital lack of development, in which case there is always an associated abnormality of the internal genitals. As a rule, there are no symptoms. Occasionally women with such abnormalities apply for treatment for the purpose of being able to perform the marital function. Operative treatment, such as that which is discussed on page 577, may be resorted to.

Most commonly atresia of the hymen, like atresia of the vagina, is due to plastic adhesions following an early vulvo-vaginal inflammation, perhaps of a gonorrhœal nature. The internal pelvic organs are normally developed.

Symptoms may occur in early childhood; they are caused by a collection of mucus which, being dammed back in the vagina, distends the imperforate hymen. The treatment is incision and evacuation of the mucoid accumulation. Symptoms of atresia of the hymen, however, rarely appear before puberty, when the condition is recognized, as in the atresia of the vagina, by the existence of severe menstrual pain without the appearance of blood. In time there will be observed a tumor which owes its origin to the accumulation of old menstrual blood. Such a tumor may involve only the vagina or it may include the vagina and uterus, in one large sac. It may be palpated through the rectum and may even be of such size as to fill a considerable part of the lower abdomen. In severe cases hæmatosalpinx may exist on both sides. The hymen is stretched and protrudes in the form of a bluish mass between the labia.

When any considerable amount of blood has been allowed to accumulate, the operation is attended with great danger of fatal sepsis. The hymen should be incised and all the contents of the sac rapidly and thoroughly evacuated under the most rigid aseptic precautions. The cavity should then be thoroughly irrigated and wiped out, and finally packed with iodoform gauze. The gauze should be removed on the second day and cleansing douches should be employed three times daily.

If the Fallopian tubes are destroyed beyond hope of future function, they should be removed by abdominal section. Veit recommends the removal of the tubes before the vagina and uterus are evacuated.

Acquired Atresia of the Vagina.—Atresia of the vagina is commonly acquired in childhood or in young girlhood. In undeveloped girls inflammation of the external genitals is especially liable to form plastic adhesions. A frequent cause of such inflammation is gonorrhœa, innocently acquired from unclean members of the family, or sometimes in hospital wards. Trauma, such as would result from falling astride a fence, has been known to set up a chronic purulent inflammation which eventually resulted in atresia. The occlusion of the vagina is due to a glueing together of the anterior and posterior walls of this canal as a result of the plastic exudate. In the great majority of cases this adhesion of the walls takes place in the lower third of the vaginal canal because here the two surfaces lie in closer contact with each other than farther up in the vagina. The occluding membrane formed by such adhesive inflammation becomes organized in due time and may acquire the thickness and consistency of the vaginal wall, or, more frequently, it assumes the form of a thick cicatricial septum. This condition is not suspected until the period of puberty is reached, when the establishment of the menstrual function makes itself known by great pain without the appearance of blood. The menstrual blood usually collects in the pouch of the vagina above the cicatricial septum. (Fig. 411.) In other instances not only the cervix, but also the entire uterine canal and vagina may be distended with blood to such an extent as to form a considerable abdominal tumor. Where the distention is extreme one or both tubes may be involved, dangerous hæmatomata being thus formed. The diagnosis is made with little difficulty. Periodic pain at the age of puberty, without the menstrual flow but with the simultaneous presence of a tumor, is sufficiently characteristic. The digital examination should first be made *per rectum*.

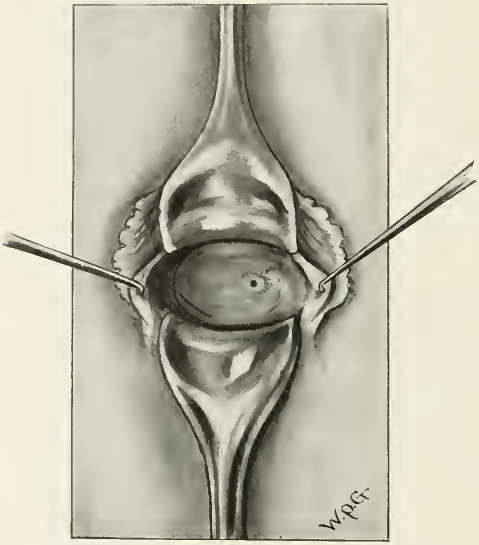

FIG. 411.—Acquired Atresia of the Vagina. The illustration shows a pinhole-sized opening at the spot where the septum had been incised for the relief of painful symptoms at the time of puberty. (Original.)

Complete atresia may occur as a result of plastic vaginitis following the severe lacerations of childbirth. The occlusion in such cases may occur higher up in the vagina near the cervix, and the cicatrices may be very dense in consistency and complicated in structure.

Atresia in elderly women is not uncommon as a result of senile vaginitis. It may exist without symptoms or it may be accompanied by a sense of general discomfort and tightness.

Partial atresia is sometimes seen in women who, at the age of puberty, receive palliative treatment for an atresia which at the time was complete. In these cases the treatment goes no further than to incise the obstructing septum and thus afford escape to the collection of menstrual blood behind it. The patient continues to menstruate with considerable regularity, but there soon develops a foul irritating discharge. This discharge, if long continued, sets up a severe pruritus. It may be so foul as to keep the patient from social intercourse. Examination will show a small pin-hole opening in the septum behind which the incompletely evacuated menstrual fluid collects and becomes infected.

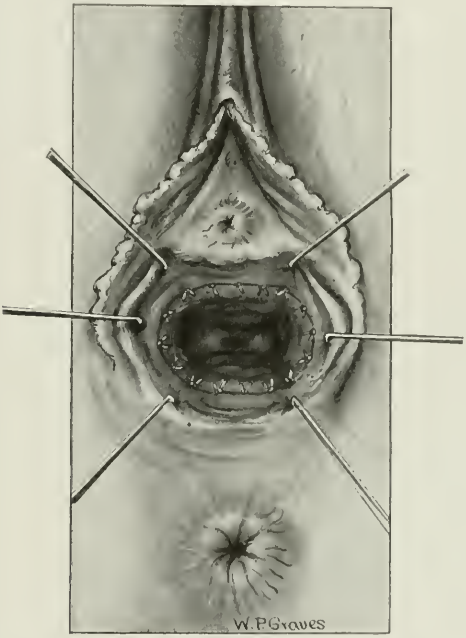

FIG. 412.—Operation for Acquired Atresia of the Vagina. The transverse septum has been dissected out, and the upper portion of the mucous membrane of the vagina has been united to the lower by interrupted catgut stitches. (Original.)

In young girls at puberty the treatment should be an evacuation, under ether, of the menstrual blood by means of a free incision of the septum and a thorough douching of the pocket beyond. Where the blood has occupied the uterus and has distended its walls extreme precautions should be taken to prevent the extension of infection to the peritoneal cavity. Where the tubes have been destroyed by distention they should be removed by abdominal section.

In cases where there is only partial atresia, or where distention from above

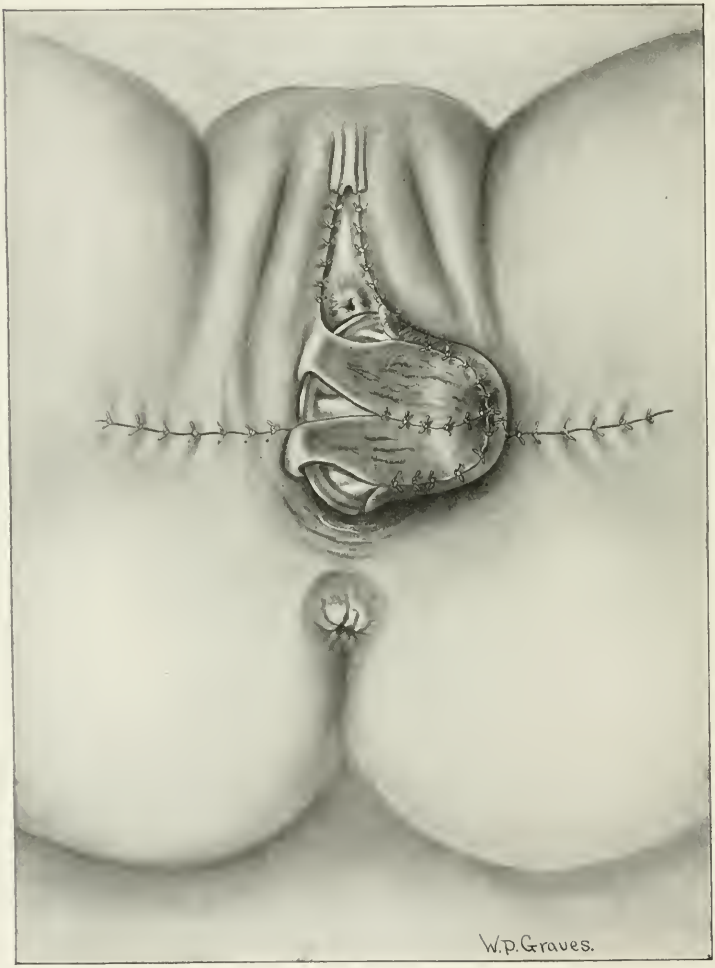

Fig. 413.—Graves's Operation for Absence of the Vagina. The four flaps taken from the labia minora and the thighs are approximated over a glass form. The wounds, at the places from which the flaps have been removed, are represented as sewed up with interrupted stitches. The pouch made by the four flaps is turned into the opening previously made by separating the bladder from the rectum.

does not clearly indicate the exact location of the septum, care should be taken, in making the first incision, not to injure the bladder or the rectum. The following operation should then be performed.

Operation for Acquired Atresia of the Vagina.—After the septum has been incised and the contents of the space beyond have been removed, there should be a thorough cleansing of the parts. The edges of the septum should then be trimmed flush with the walls of the vagina. All scar tissue should be removed so as to prevent a future contraction. When the septum has been completely cleared away it will be found that there remains a denuded area which extends like a ring around the inner circumference of the vagina. The mucous membrane of the upper portion of the vagina should then be drawn down and approximated to that of the lower portion by interrupted catgut sutures. Such an operation should restore perfectly the normal calibre of the vagina and should not be followed by a tendency to the development of a stricture. The use of antiseptic douches twice or three times daily should be begun at once after the operation and should be kept up until the discharge shall have completely disappeared.

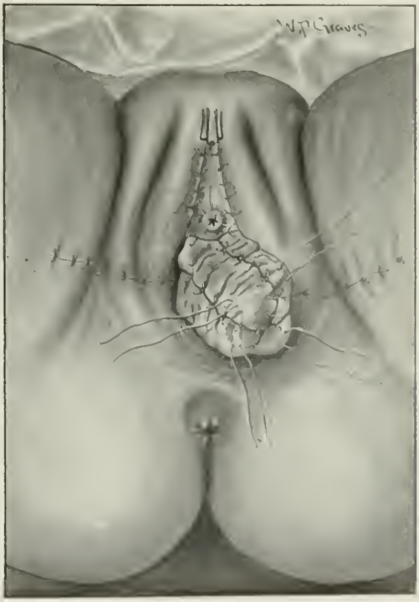

Fig. 414. Second Stage of Graves's Operation for Congenital Absence of the Vagina. The glass form has been removed and the seams of the pouch completely sewed. The untied sutures seen issuing from the pouch were previously passed through the vault of the artificial opening made between the bladder and the rectum. The pouch is inverted into the artificial opening and the stitches are then tied so as to prevent any prolapse of the pouch before it becomes attached, by healing, to the raw surface of the opening. (Original.)

Congenital Atresia of the Vagina.—Congenital atresia of the vagina occurs in various forms. The vagina may be completely absent, in which case the bladder and rectum lie in immediate juxtaposition, separated only by loose areolar tissue. In other cases the vagina may be only partially formed, the vaginal canal being in part or completely occluded. The internal pelvic organs are usually present but incompletely developed. Cases of absence of the vagina may in rare instances be associated with entire absence of the uterus, tubes, and ovaries. As a rule, however, some evidence of the presence of rudimentary organs can be made out by rectal examination.

The indication for surgical treatment in these cases is twofold. Most commonly, where the uterus and ovaries are present and perform their functions, surgical intervention is imperatively needed to establish drainage. Less commonly, the surgeon is called upon to establish a vagina purely for the purpose of copulation. It is an extraordinary fact that in most of the cases where there is entire atresia of the vagina, associated either with rudimentary or with complete absence of the pelvic generative organs, all secondary sexual characteristics are normally present. Sexual desire and personal attractiveness may exist in a high degree. Such women sometimes wish to marry, and the question of making an artificial vagina becomes an important one. Numerous methods have been devised, but for the most part they have been unsuccessful. More than one excellent authority advises against the attempt to make an artificial vagina for the purpose of copulation, considering it to be an unjustifiable procedure. The method of separating the rectum and vagina and maintaining the opening by a vaginal plug has resulted in failure, excepting in some cases where the operation was performed for drainage only. One operator has succeeded in grafting on the raw surfaces of the artificial opening the mucous membrane removed from a case of procidentia. Abbe and Burrage have obtained successful results by turning in flaps from neighboring parts and suturing them so as to line the artificial pouch and thus prevent granulation and ultimately stricture.

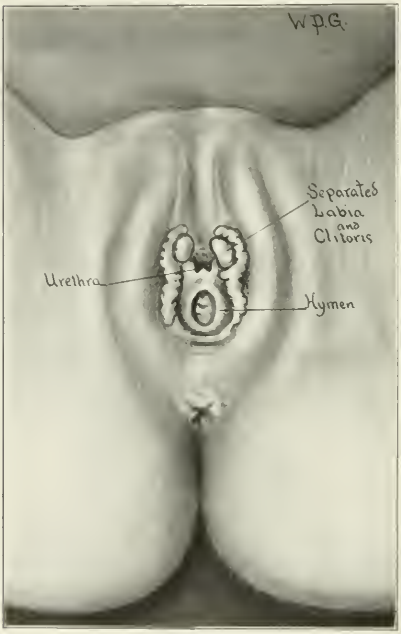

Fig. 415. Epispadias. (Original.)

The operation about to be described was devised by the writer, and successfully performed by him; it corresponds in its essentials to the operation performed by Burrage. If sepsis can be avoided the operation should always be successful. It can be employed either for purposes of drainage or for the creation of a vagina suitable for coition. The patient is placed in the perineal position. A superficial transverse incision is made just below the urethra. Through this transverse slit the bladder and rectum are slowly dissected apart with the finger. The forefinger of the left hand should be kept in the rectum and some blunt instrument like a urethral dilator should be held in the bladder by an assistant. The dissection should be carried on by the right forefinger, the left forefinger behind and the blunt instrument in front acting as guides to prevent tearing into the wall of the rectum or bladder. In this way an artificial opening can be made of the exact proportions of the normal vagina. Care should be exercised not to enter the abdominal cavity. The next step is to line this cavity with a pouch of skin made up of flaps turned in from the surrounding parts. To accomplish this, the two labia minora are dissected off, from above downward, in such a manner as to leave a pedicle sufficiently large to furnish good circulation. The two surfaces are then split apart so that two paddle-shaped flaps remain. There should then be dissected, from the inner side of the thigh, two similar flaps which have their bases at the two lower corners of the artificial opening. All four flaps are then sewed together over a glass form, as shown in the cut. (Fig. 413.) Before the flaps are sewed together several catgut sutures, with the ends left long, should be placed in the vault of the artificial cavity. When the skin pouch has been nearly completed, the glass form is removed and the catgut sutures are brought out through the skin pouch. The pouch is then inverted and the sutures are tied in such a manner that the pouch fits snugly into the artificial cavity. (Fig. 414.) With careful after-treatment primary union should result, and there should be no future contraction of the canal.

Hypospadias and Epispadias.—Hypospadias is the term applied to a defect in the lower portion of the canal of the urethra, while epispadias relates to a defect in the upper portion. Epispadias is apt to be associated with a failure of union of the pubic bones in the median line, as a result of which a cleft remains. This condition may be so marked as to allow the bladder to extrude. The labia minora and clitoris usually fail to unite, as seen in the accompanying cut (Fig. 415). Incontinence of urine is the usual symptom. Successful results from operation are very difficult to secure. No definite rules for operation can be laid down. Such an operation should be attempted only by a surgeon skilled in plastic work.*

Double Vagina.—This condition is associated with a uterus septus. There exists, in the vagina, a partial or complete longitudinal septum, which may interfere with coition or with childbirth. The operation consists in removing the septum with a pair of scissors and uniting the edges of the mucous membrane with interrupted catgut sutures. There is little bleeding.

IV. PLASTIC OPERATIONS IN THE VAGINA.

General Considerations.—After the patient has been carefully examined and a thorough knowledge of her condition has been obtained, it becomes necessary to determine whether it is wise to proceed at once to the performance of the operation which the disease or injury calls for, or whether it may not be more advantageous to postpone operative interference until, through the adoption of suitable measures, the patient's general health and the condition of the parts in the immediate vicinity of the seat of the injury or the focus of disease shall have been improved. It is not usually necessary to prescribe a protracted building-up treatment for these patients, although in quite a large percentage of cases they are noticeably run down as a result of their condition. It should be remembered that operations on the vagina, even though of long duration, are rarely accompanied by any degree of shock, and that the rest in bed which is enforced during the period of convalescence usually proves of great benefit, especially in the class of patients who ordinarily frequent general hospitals. In certain cases, however,—as where there is a profuse purulent discharge which comes from an excoriated area of either the vagina or the cervix,—it is desirable not to operate until treatment with cleansing douches and with local antiseptic and astringent applications has been carried on for a period of two weeks or longer.

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* See an article by Mayersbach, in the Wiener klin. Wochenschrift, 1909, xxi., No. 52

Contra-Indications to Operating.—Owing to the fact that plastic operations in the vagina produce only slight constitutional disturbance, it is only in exceptional cases that the patient's condition is such as to contra-indicate operative interference. In a case of diabetes the operation should be postponed until, through dietetic treatment, the amount of sugar in the urine is reduced to a minimum. A postponement would also be necessary in any case in which there is a septic or purulent discharge, whether it comes from the vaginal wall, from the cervix, or from the body of the uterus; nor would it be proper to operate in the presence of an acute pelvic inflammation. Aside from these local reasons for not operating there are others which hold good with reference to any operations which necessitate the prolonged employment of a general anæsthetic—for example, the presence of a bronchitis or other pulmonary disturbance, especially in a fat subject.

Preparation of the Patient for Operation.—The ultimate success of the operation, in plastic work upon the cervix uteri or the vaginal wall, depends in no small degree upon the care with which the patient has been previously prepared. It is well to administer a mild cathartic—rhubarb pill (5 grains) or the pill of aloes, strychnia, and belladonna—every night for three or four nights before the operation. Twenty-four hours before the operation, from a quarter to half an ounce of magnesia sulphate is given. Then, after a full warm bath, the skin in the neighborhood of the vulva is thoroughly shaved. In some cases it may seem preferable, for personal reasons, to shave the patient at the time of the operation, while she is under the influence of the ether, but it is rarely necessary to do this. After the shaving has been completed, the groins, buttocks, thighs, anus, vulva, and vagina are well scrubbed with green soap and water. This is followed by douching the vagina with sterile water. Afterward a high enema, consisting of one quart of soapsuds with 1 drachm of spirits of turpentine, is administered. A pad soaked in corrosive sublimate solution, 1:3,000, is then applied over the vulva and anus, and held in position by a T-bandage, which should be changed at the end of eight hours. Early on the morning of the operation all the steps just described—the scrubbing, the douching with sterile water, the administration of an enema, and the application of a bichloride pad—should be repeated. In giving the enema on the morning of the day on which the operation is to be performed, the bowel should be washed out until the escaping water is quite clear.

After the patient has been etherized and placed on the table in position, the vulva, buttocks, thighs, anus, and vagina should again be scrubbed with green soap and water, and irrigated with sterile water. In cases of cystocele or procidentia this should be preceded by catheterization with a sterilized glass catheter.

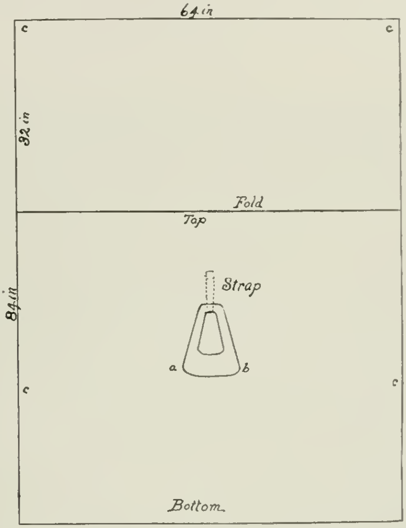

Fig. 416.—Diagram to Show the Manner of Preparing the Ewin Perineal Sheet.

The sheet for vaginal operations performed in the dorsal position is made eighty-four inches long by sixty-four inches wide. One end is folded so that the corners marked *c* join *c* on each side, and the seams are closed, thus forming a pocket. The opening for the vulva should be six inches long, two and one-half inches wide at the bottom, one inch and three-quarters wide at the top. The lower facing, from *a* to *b*, is made double to give a thicker covering over the anus. The edges of the opening are finished with a narrow binding. From the top of the opening, on the under side, fasten a strap, ten inches long by two inches wide, in the manner indicated by the dotted line on the diagram.

To cover the patient, gather the top edge of the pocket in one hand, and cover the feet so that the toes of each foot come into the corner of the pocket, care being taken to locate the opening directly over the vulva. The strap on the under side must be pinned securely to the patient's night dress. The sheet is tucked well under the buttocks, the long end being left to cover the pad.

For lacerations of the perineum that have extended through the sphincter ani into the rectum, there is required a special preparation which will be described under Operations for Complete Tear. (See page 605.)

Position of the Patient on the Operating Table.—Plastic operations in the vaginal canal may be performed in either the perineal position or in what is known as the Sims position.

The Perineal Position.—Most vaginal plastic operations are performed in the perineal position, the patient being on her back, and the thighs being drawn well up on the abdomen, with the buttocks extending slightly over the end of the table. This position should be maintained by two assistants, the nurse to the right of the patient and the operating assistant to the left. The use of mechanical devices, such as stirrups, straps, sheets, etc., for keeping the patient in the perineal position, is not recommended by the writer, except in cases of emergency and where assistants are lacking. Such devices serve not only to constrict the popliteal vessels, sometimes causing a troublesome phlebitis, but they also prevent the changing of the position of the patient during the operation, as is sometimes necessary. Operations for cystocele, for lacerations of the perineum, and for all ordinary cases of lacerations of the cervix, are done in the perineal position.

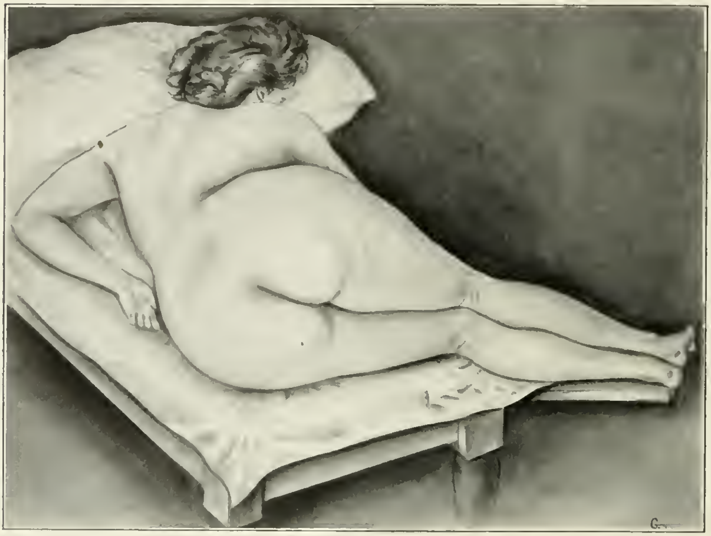

Fig. 417.—Correct Sims Position.

The left hip is in relation with the lower left-hand corner of the table. The right shoulder is in relation with the right-hand edge of the table. The left arm is back of the patient. The legs are arranged, as described in the legend of Fig. 416, on the Sims extension shelf. The nurse stands to the left of the operator and holds the speculum in her right hand. The assistant is to the right of the operator on the other side of the extension shelf.

The important points to be observed are the position of the left hip and the right shoulder.

It is often an awkward and annoying matter to keep the sterile sheet and towels which cover the patient in position during a long plastic operation, and for that reason it is convenient to have a specially made sheet which will satisfactorily cover the patient and remain in position during the operation. A most convenient perineal sheet is that devised by Miss H. J. Ewin. It is shown in the accompanying cut. (Fig. 416.)

The Sims Position.—In operations where it is necessary to secure the greatest amount of room for manipulation in the vagina—as, for example, in the repair of greatly mutilated cervices, in the removal of cervix stitches, in operations for vesico-vaginal and recto-vaginal fistulæ, and in Dudley's and Baker's operations for anteflexion of the uterus—the Sims position is used by preference. In this position the vagina is opened up much more widely than in the perineal position, owing to the gravitation of the pelvic viscera toward the abdominal wall. In order to obtain the full advantage of this position, it is very necessary to observe certain precautions in placing the patient. The table should be provided with a Sims shelf. It is important that the left hip of the patient should be as nearly as possible in relation with the lower left-hand corner of the table, while the right shoulder of the patient should be in relation with the right-hand edge of the table. The arms and legs should be arranged as in the accompanying diagram. (Fig. 417.)

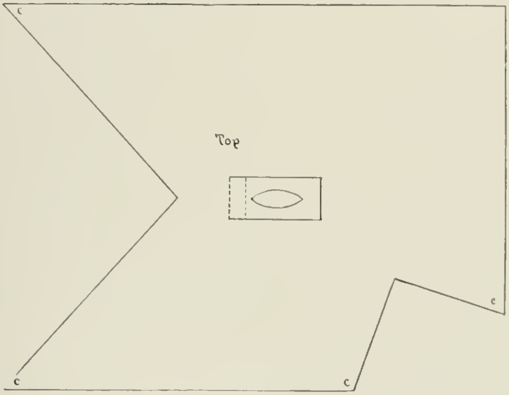

FIG. 418.—Diagram Showing how the Ewin Sheet is Made for Use when the Patient is to be Operated upon in the Sims Position.

The Sims sheet is eighty-four inches long by sixty-four inches wide. Close the seam on either end so that the corners marked *c* join. Make the opening for the vulva elliptical in shape, six inches long and one inch and a half wide in the centre. This should have a wide facing, having the part marked *a b* double; the edges of the opening should be bound with narrow binding.

To adjust the sheet, gather the upper portion in both hands, and lay the opening directly over the vulva. The part of the sheet in the left hand will fall into place over the buttocks, while that in the right covers the legs on the Sims extension. As an assistant lifts the right leg tuck the sheet securely between the thighs to prevent slipping.

It is even more difficult to maintain a sterile covering with the patient in this position than in the perineal position, and the Ewin sheet, as designed in Fig. 418, is especially recommended for use in this position.

Assistants Needed by the Operator.—It is necessary to have two assistants: first, a nurse who stands to the left of the operator and holds the right leg of the patient, if she is placed in the perineal position, or the speculum, if she occupies the Sims position; and, secondly, an assistant who stands to the right of the operator. Intelligent sponging on the part of the assistant is sufficient to keep the operative field clear of blood, and does away with the entirely unnecessary practice of irrigation, which requires additional and often inconvenient apparatus and an extra assistant, and which serves to keep the field of operation and surrounding sheets and parts in a wet and disagreeable condition.

Operative Technique.—With regard to the technique of plastic operations, the greatest care and accuracy must be employed in the denudation of tissues, in order to secure exact coaptation of the edges of the wound without undue tension of the tissues. It is impossible to lay too great emphasis on the importance of this point, for it is only by the observance of it that primary union and the avoidance of sepsis may be secured. It is to be constantly remembered that it is impossible to keep the field of these operations surgically clean, and that most failures result from the entrance of sepsis into clumsily and inaccurately apposed edges. It is, therefore, imperative that in all cases the field of denudation be carefully mapped out beforehand; and, in order to secure the exact approximation of opposing denuded surfaces, a most careful sense of symmetry must be cultivated. Speed should unhesitatingly be sacrificed to extreme carefulness, for, owing to the slight degree of shock which attends vaginal plastic operations, speed is usually not required.

The most accurate method of mapping out an area for denudation is to insert tenacula into the angles of the figure to be denuded. By drawing the tenacula taut a straight ridge of vaginal mucous membrane is presented between the given angles. From this ridge there can be removed, with the Emmet scissors, a strip which leaves a smooth even outline for the denuded figure, and insures clean and perfect coaptation of the edges of the wound. On account of the folds and rugæ of the vagina, it is difficult in any other way to denude a line between two given points, without leaving it ragged and tortuous, and thus interfering with the accurate approximation of the margins of the wound.

With regard to the comparative merits of denudation by Emmet's method with scissors, and of the method of splitting away the flap of vaginal mucous membrane by dissection, the writer earnestly recommends the former for all plastic operations on the vagina. With Emmet's method of denudation there is less bleeding, there is also less danger of wounding the bladder or the rectum, and no dead spaces are left, while the retention of a considerable quantity of connective tissue and muscular fibres which by the other method would be dissected away, aids greatly in securing a firm and elastic support.

Sutures.—The materials commonly used for sutures are chromicized catgut, silkworm gut, and wire.

It is necessary to use catgut to a great extent in the vagina because of the fact that it is absorbable. It should always be remembered, however, that catgut is a fertile source for the entrance of sepsis, and that it should be a general principle to use as little of it as possible. This result may be obtained by apposing denuded surfaces in such a manner that a minimum number of sutures will be required. Catgut sutures should always be interrupted, never continuous, and knots should be tied closely, and the ends cut close to the knot.

Number 1 catgut is the size generally to be used. Catgut sutures may be employed for the repair of the cervix, in those cases in which the tissues are not greatly infiltrated or cicatrized; for the repair of cystocele; and for the repair of the internal portions in operations for lacerated perineum.

Silkworm gut, being less liable to encourage infection, may be used anywhere where the ultimate removal of the sutures is practicable—for example, in operations on the cervix, and in the external portions of operations for lacerations of the perineum.

Wire is the best suture for exact approximation of the edges of a wound, and for employment in wounds where there is considerable tension, as in complete tear of the perineum; in operating upon an hypertrophied cervix; in cases where there is special danger of infection, as in those of vaginal fistula; and in operations upon a septic eroded cervix. The best wire suture is nickel-plated copper wire number 27, which is just as serviceable as silver wire and less expensive. The very fine wire recommended by some surgeons has too great a tendency to cut into the tissues.

Instruments.—The special instruments necessary for plastic surgery on the vagina are: right and left Emmet's scissors, a broad operating Sims speculum, a weighted perineal speculum, several sharp tenacula with long handles, two pairs of bullet forceps, and a long needle-holder, preferably a Burrage needle-holder.

If silver wire is used on the cervix, it is convenient to have the wire-twisting implements which were devised by Emmet.

Care of Patient During Convalescence.—As has been intimated, sepsis is the great enemy of successful plastic surgery, and to avoid this danger the after-care of vaginal operations is as important as the preparation and the methods of operating. In general hospital practice it is the safest plan, in perineal cases, to keep the legs tied for twenty-four hours, and longer in cases of intractable patients, while a roll should be kept under the knees.

Twenty-four hours after operation the employment of sterile water douches twice each day should be instituted. After each urination the stitches should be irrigated with sterile water. The urine should be voided within eight hours after operation, and, if the patient is unable to do so voluntarily, she should be catheterized. Patients should be encouraged in every way to void their own urine, on account of the danger of causing a cystitis by catheterization. After operations for cystocele, special rules for catheterization should be observed. (See page 610.)

For the first week after operation, in perineum cases, or until the stitches are taken out, a cathartic is given each night, while in the morning a soapsuds enema is given before voluntary defecation, to avoid tension on the stitches.

Perineal stitches are usually removed nine days after the operation. In a case in which wire stitches have been used in the cervix, and in which at the same time the lacerated perineum has been repaired, the wire stitches should not be removed until five or six weeks following the operation, in order to avoid possible damage to the perineum in their removal.

Daily hot-water douches should be taken by the patient for at least three weeks after discharge from the hospital.

Patients upon whom an operation for the repair of the perineum has been performed may be allowed to sit up in bed on the ninth or tenth day, and are usually up and dressed by the twelfth day following the operation.

In cystocele cases and in cases of complete tear the patient should remain in bed for three weeks.

In cases where the cervix has been repaired without perineorrhaphy, the patient may be up and dressed in one week.

Special after-treatment in cases of cystocele and complete tear of the perineum will be described under the appropriate headings.

Repair of the Lacerated Cervix; Trachelorrhaphy.—The repair of lacerations of the cervix presents many mechanical difficulties, and requires considerable experience and technical skill. Among the operations in plastic surgery of the vagina, trachelorrhaphy is one of great importance. The general constitutional symptoms resulting from a lacerated cervix uteri, especially those of the nervous system, are frequently so severe as to impair greatly the woman's health and usefulness. The skilful repair of the cervix in such cases will usually produce a most satisfactory cure. On the other hand, a clumsily executed operation, resulting in an unnatural and mutilated cervix, will leave the patient in no better condition, with regard to symptoms, than she was before operation. The deleterious influence of a lacerated or a mutilated cervix on the general nervous constitution of a woman, though little understood, is a well-established and important fact. Bearing this in mind, the surgeon should aim, in his operation for the repair of a lacerated cervix, to restore it as nearly as possible to its normal contour and consistency. Fortunately, the cervix, when properly manipulated, has the power of returning almost completely to its original consistency, while, on the other hand, when improperly treated, it is peculiarly liable to distortions and to the formation of deep cicatrices, which are as great a detriment to the patient's health as was the original laceration.

Indications for Operation.—It is not necessary to operate on every case of lacerated cervix, for tears of considerable extent are not infrequently followed by no deleterious results. Operation is indicated when tears are followed by congestion and hypertrophy of the cervix. The cervical glands become pockets of chronic inflammation, and, their ducts being choked, they become large and cystic. In this way the cervical mucous membrane is swollen and rolls outward, giving the condition of eversion, which is often wrongly termed ulceration or erosion of the cervix. In the angles of the laceration there is usually a considerable amount of dense, hard cicatricial tissue which doubtless has an important reflex influence in producing the symptoms. The cervix is bathed continually in a muco-purulent discharge which contains a variety of bacterial organisms. Such patients usually suffer from general physical and nervous depression, sacral backache, and pains in one or both sides. Besides the general impairment of health which a cervix thus diseased causes, the affected part is peculiarly liable to become carcinomatous. The damage should therefore be repaired in all cases.

Whenever plastic operations of any kind are being performed on the vagina, even small tears of the cervix should always be repaired as a matter of routine.

Chronic inflammation and eversion of the cervical mucous membrane may occur in nulliparous women, and the condition may very closely simulate a laceration, both in physical appearance and in the symptomatology. Such a cervix requires operation.

Instruments.—The only special instruments necessary for the operation of trachelorrhaphy are: tenaculum forceps (or bullet forceps), special needles, and a special needle-holder. An appropriate needle of at least two different lengths is of very great importance, as the passing of sutures in operations of the cervix is often attended with extreme difficulty, to which is also added the danger of breaking the needle in the tissues. Emmet's half-curved cervix needle (Fig. 419) is the one most to be recommended. The best needle-holder for use is the Burrage needle-holder (Fig. 420), the advantages of which are that the needle can be held at any angle between the jaws of the holder, and also that, there being no clamp, there is much less likelihood of breaking the needle.

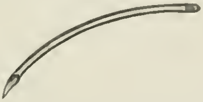

FIG. 419.—Emmet's Round-eyed, Half-curved Cervix Needle (somewhat magnified).

Suture Materials.—In ordinary cases of lacerated cervix, where the cervical tissue is soft and where there is little inflammatory action, chromicized catgut number 1 may be used. It should always be remembered, however, that catgut, even when introduced into a cervix with the greatest care, creates a certain amount of danger from sepsis, with resulting non-union of the denuded surfaces. On the other hand, silkworm gut may be used in all cases, and is less liable to infection. It possesses the disadvantage that, if allowed to remain in the tissues for a certain length of time, it produces irritation and sometimes actual sepsis. It is not recommended by the writer. In certain cases silver wire is the most suitable material. It is no more difficult to remove than is silkworm gut. It is even less liable to infection, and is superior to any suture in securing perfect approximation of the edges of the wound. Silver wire may be used where there is special danger of infection, or where tension in bringing the denuded surfaces together is required. On the other hand, it should be remembered that the removal of wire stitches may tear open a well-united wound, while the danger of leaving in a stitch or a part of a stitch is always present.

As already stated at the beginning of this article, the danger of infection may be greatly diminished by a course of preliminary local treatment. Undue tension in approximating the denuded surfaces should be avoided by performing the operation in such a manner that all hypertrophied and cicatricial tissue is removed, thus allowing the denuded surfaces to fall naturally together without tension. When these results have been accomplished, chromicized catgut is the most satisfactory suture.

Position of the Patient on the Operating Table.—In most cases the perineal position and the employment of a weighted speculum give sufficient room in the vagina for operations on the cervix. However, in cases where there is very deep

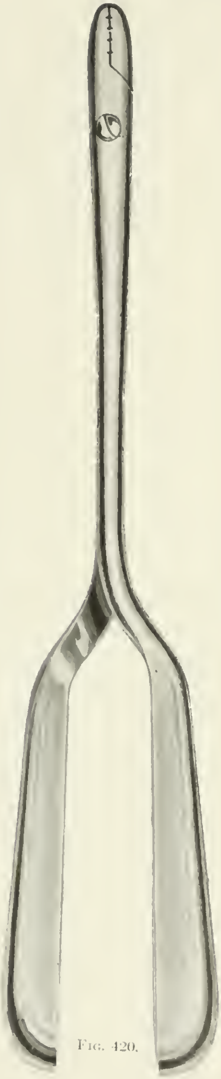

Fig. 420.

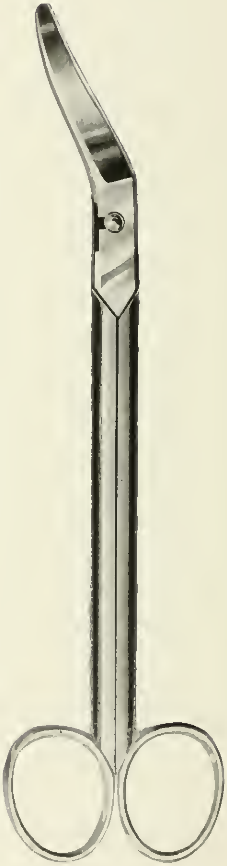

Fig. 421.

Fig. 420. The Burrage Needle-Holder for Plastic Work on the Vagina. (Natural size.) The advantages of this needle-holder are that it can be held in any position in the hand, and that the needle can be held at any angle between the jaws. The jaws are copper-faced, so that a good grip can be taken of the needle without danger of breaking it.

Fig. 421.—Emmet's Denuding Scissors. The cut shows the correct form of the blades.

laceration, or where there are great hypertrophy and much infiltration of the lips of the cervix, the surgeon can work to greater advantage with the patient in the Sims position, care being taken to observe the rules explained on page 583.

Technique of the Operation.—The operation should always be preceded by a gradual dilatation and a thorough curetting of the cervical canal. The anterior and posterior lips are then drawn widely apart with the tenaculum forceps, and the central raphe of the cervical mucous membrane is carefully noted on both anterior and posterior lips. The constant noting of the relations of the surrounding parts to the raphe is of great importance for the eventual result of the operation, for it is only in this way that the denudations can be made in a symmetrical manner and distortion of the cervix avoided. The area which is to be denuded is then marked out with a knife at each lacerated sulcus, great care being taken to provide that, when the denuded surfaces of the anterior and posterior lips are brought together, they shall accurately fit each other. The denudation should begin at a distance of about three-sixteenths of an inch from the central raphe, and the area denuded should have such a width that, when the apposed surfaces shall have healed, the lateral walls of the cervix will be of normal thickness. The denudations should be made so that the cervical canal will be trumpet-shaped; otherwise there is danger of making the cervix too conical. The tissue should be removed by a very sharp scalpel, placed longitudinally with the axis of the cervix, and passing through, upward, and outward. The tissue is best removed by a slight rapid sawing motion of the knife. Emmet's scissors (Fig. 421) may also in some cases be employed to advantage. Scar tissue in the angles of the laceration should all be removed. There is very little danger of bleeding, excepting in deep lacerations that extend to the vault of the vagina. Occasionally the excision of scar tissue from such a laceration wounds a branch of the uterine artery and causes an alarming hemorrhage, which a stitch in the angle is unable to control. In such a case, a large full-curved needle, to which are attached several twisted strands of silver wire, should be passed boldly and deeply up into the uterine tissue, and the wire tightly twisted. This may be removed later. Such a needle should always be kept sterilized in the operating room. The sutures are introduced in the manner shown in Fig. 423. The first two are placed at the angles, and there are usually three or four on each side.

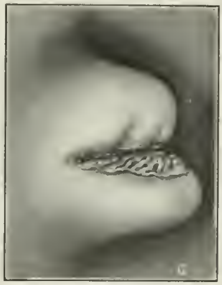
FIG. 422.—A Typical Laceration of the Cervix Viewed Laterally. Note the fact that one lip is longer than the other and shows eversion of the mucous membrane. (Original.)

The operation for repair of the cervix, as has been stated, may at times present very great difficulties. These difficulties nearly always arise from one of two conditions, or from a combination of both. In the first condition there is a difference in the lengths of the anterior and posterior lips, and in the second there is great hypertrophy of one or both lips, resulting in a hard cicatricial eversion of the cervical mucous membrane.

Operations Where one Lip is Longer than the Other.—This condition may

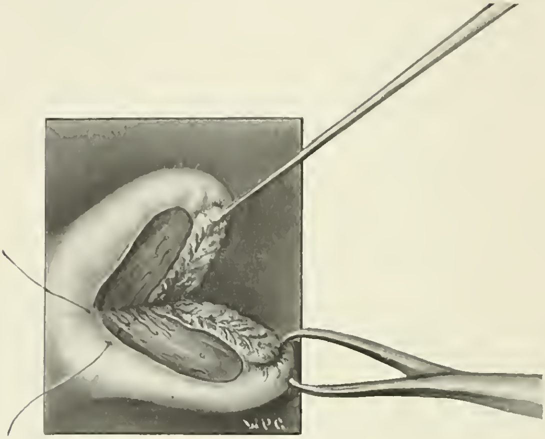

Fig. 423.—Laceration of the Cervix in a Case in which the Two Lips are Unequal. The drawing shows the method of inserting the first suture, so that when drawn taut it will create a new angle and make the lips equal in length. (Original.)

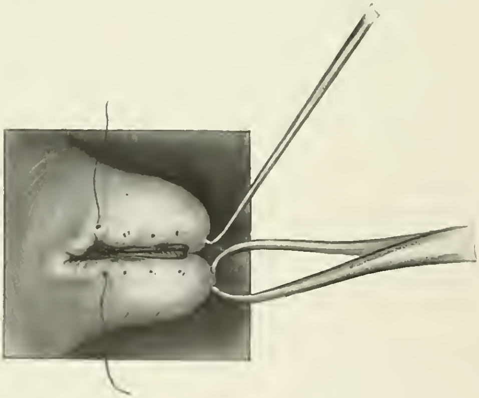

Fig. 424. Laceration of the Cervix where One Lip is Longer than the Other. This drawing and that of Fig. 423 show the method of making the two lips of the cervix equal by means of tenacula and thus creating a new angle. The method of placing the sutures so as to render the new angle permanent and the lips equal in length is shown in the present drawing. (Original.)

be easily overcome by a simple mechanical procedure. Before denuding the lacerated angle, the surgeon should grasp the anterior and posterior lips with tenaculum forceps and should force them to an exact equality by pushing on the longer lip and pulling on the shorter lip. With the lips in this position, he should mark out the area of denudation with a scalpel. The work of denudation is then carried on as before. When placing the stitches he should again bring the lips to an equality and should place a tenaculum in the new angle thus formed. With this new angle as a guide, the stitches can then be placed symmetrically on each side of it, so that, when they are tied, the anterior and posterior lips are found to be of the same length. A glance at Figs. 423 and 424 will make this point perfectly clear.

Operation Where There is Great Hypertrophy of the Lips.—Many cases of neglected laceration of the cervix present the appearance seen in Figure 425. These cases are both the most difficult to operate on and the most important, as they usually present the worst symptoms and are said to be peculiarly susceptible to cancer. The hypertrophy, in these cases, results from an increase of the muscular and connective-tissue elements of the cervix, from a chronic infiltration of lymphocytes between the fibres, from a blocking of the opening of the cervical glands, with consequent cystic dilatation, and from an hypertrophy and congestion of the cervical vessels with consequent œdema. These cases sometimes require three or four weeks of preliminary treatment to effect a depletion of the organ. This result may be attained by deep and frequent scarification, or preferably by the employment of daily hot douches, with an application, two or three times a week, of Churchill's tincture of iodine and glycerin tampons soaked in a twenty-five-per-cent solution of ichthyol and glycerin.

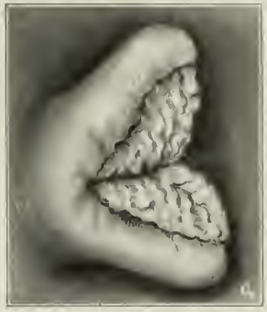

FIG. 425.—A Deep Bilateral Laceration of the Cervix Seen from the Side. Note the great hypertrophy and the eversion of the cervical canal. (Original.)

In very severe cases the operation of low amputation may be performed as described on page 595. This, however, is rarely necessary, and, if possible, it is preferable to perform the operation now about to be described, as it leaves the cervix in a perfectly normal and unmutilated condition.

Method of Operating in Severe Cases.—The denudation of the angles is first performed in the manner before described. It will now be seen that the denuded surfaces of the anterior and posterior lips cannot be approximated on account of the rigid protruding hypertrophy of the cervical canal. In order to reduce this protrusion on either or both lips a transverse wedge is removed from one or from both lips. (Fig. 426.) The surfaces exposed on the removal of the wedge are then approximated by number 1 chromicized catgut sutures. (Fig. 427.) It will now be found that all difficulty in approximating the lateral denuded surfaces has disappeared, and the sutures may be applied in the regular way, care being taken in passing the needle not to cut the catgut sutures which approximate the transverse wedge surfaces. Silver-wire sutures for the lateral wounds are especially useful in this operation, both because there is greater danger of sepsis (by reason of a pre-existing chronic inflammatory condition), and because in such cases the entire cervical tissue is much stiffer and more unyielding, and requires for ultimate union the firm support given by wire sutures.

The operation just described was devised by Dr. W. H. Baker, and is recommended because it is applicable in nearly all cases, and because it results in a cervix which is normal in appearance and in consistency.

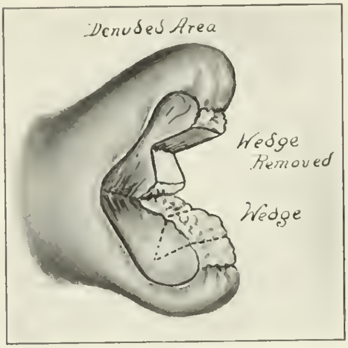

Fig. 426. Laceration of the Cervix. Method of removing wedges from the anterior and posterior lips in cases of hypertrophy and eversion. The drawing shows the lateral denudation and the wedge removed from the upper lip. The dotted line shows the place in the lower lip from which a wedge is to be removed. (Original.)

Schroeder's Operation.—The operation devised by Schroeder is a most useful one for greatly enlarged cervices where the increase in size is due chiefly to an hypertrophy and dilatation of the cervical glands, and where there has been no deep laceration. (Fig. 428.) Such cervices are not infrequently seen in nulliparous women, and are sometimes the result of a run-down, nervous and anæmic condition or of a chronic gonorrhœal endocervicitis. The discharge, which is profuse and glairy, is a most annoying symptom, and often completely resists local treatment. By Schroeder's operation (Figs. 429 and 430) the diseased glandular structure is entirely excised, and affords a complete cure for the profuse mucous discharge. The steps of the operation are as follows:—

The cervix is first divided bilaterally nearly to the internal os and the lips are held widely apart. The gland tissue is then excised, in the form of a wedge, by two oblique incisions, as represented in the diagram. (Fig. 430.) This is done first on the posterior and then on the anterior lip. Deep catgut sutures are so placed as to approximate the vaginal flap of the cervix with the intracervical flap. The wounds on the sides are then closed by catgut or silver-wire sutures, as in the classical Emmet's operation.

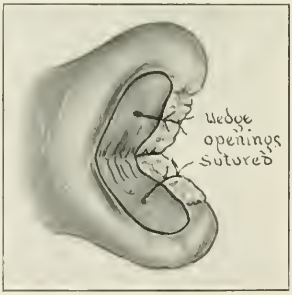

Fig. 427.—Laceration of the Cervix with Hypertrophy and Eversion. The drawing shows the lateral denudation. The wedges have been removed from both lips and sutured. The cervix is now ready for final suturing in the ordinary way. (Original.)

Amputation of the Cervix.—Operations for amputation of the cervix are classified into high amputations and low amputations.

High Amputation.—This operation is indicated in cases of malignant disease or of hypertrophy accompanied by elongation of the cervix. It is indicated chiefly in long-standing cases of procidentia. In procidentia the hypertrophy usually occurs only in the region of its external os, the rest of the cervix being long and attenuated as a result of long-continued traction. In such conditions the cervix may attain a length of five or even six inches, while the body of the uterus itself may be small and atrophied. In cases of procidentia it will usually be found that the hypertrophied, lacerated, and angry-looking cervix rapidly diminishes toward the uterus into an attenuated tube, often not much exceeding in diameter that of a lead pencil. (See Operations for Procidentia, page 611.)

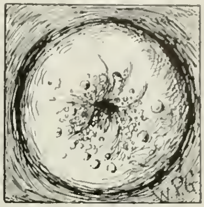

Fig. 428.—Type of Cervix Suitable for Schroeder's Operation. Great cystic hypertrophy with little laceration. (Original.)

Technique of the Operation.—The length of the cervical canal is first estimated as nearly as possible by means of a graduated uterine sound. *The canal should not be dilated*, as dilatation causes such stretching and thinning of the wall of the cervix that it is difficult to remove it without tearing through into the canal—an accident which greatly hinders the operation. A sound is passed through the urethra into the bladder, and the line where the latter organ is reflected upon the surface of the elongated cervix is carefully noted. Bearing in mind the relations of the bladder to the part to be operated upon, the surgeon should make a circular incision about the cervix, just beneath the line of attachment of the bladder. The bladder, vaginal wall, and rectum are then slowly pushed away from the cervix by means of gauze held between the thumb and fore-finger, as shown in Fig. 431. This procedure should be carried out chiefly by means of gauze, although it is occasionally necessary to cut some of the connective-tissue fibres. The use of gauze prevents troublesome bleeding and protects the bladder and rectum from injury. Under these manipulations the circumference of the cervix should become rapidly smaller, and the organ itself, when thus drawn out, should present the appearance of an elongated cone. (Fig. 431.) When the stripping has reached the point where the cervix should be amputated, the knife is applied and the tissues are divided in such a manner as to leave the edges of the mucous membrane sufficiently exposed to allow the passage of sutures without difficulty.

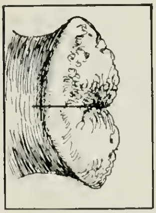

Fig. 429.—Schroeder's Operation. First incision, shown by the horizontal line. (Original.)

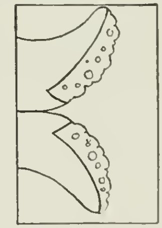

Fig. 430. Schroeder's Operation. Method of excising the hypertrophied gland tissue. The diagram represents a sagittal section (Original.)

The manner of passing the sutures first through the mucous membrane of the uterus and then through that of the vagina is of great importance in this operation. The plan of carrying radiating sutures around the whole circumference of the wound is not generally approved. It is impossible by such sutures to secure correct approximation of edges, and as a result the sutured parts present a puckered, baggy appearance, suggestive of the almost certain development of sepsis. The best method of uniting the cut surfaces is shown in Fig. 432; it represents the so-called Hegar's method. It is important to note that three sutures are first passed through the upper half of the uterine mucous membrane in a radiating direction. In the same way three sutures are next passed through the lower half of the uterine mucous membrane to the lower half of the vaginal mucous membrane. Deep lateral sutures are then passed in such a manner as to include the loose connective tissue which has been stripped from the sides of the cervix and in which lie the branches of the cervical arteries. These lateral sutures completely control any hemorrhage that is likely to occur. If the operation has been accurately and carefully performed, the parts, when healed, should present very much the same appearance as does a normal cervix. Their appearance, immediately after the operation has been completed, is shown in Fig. 433.

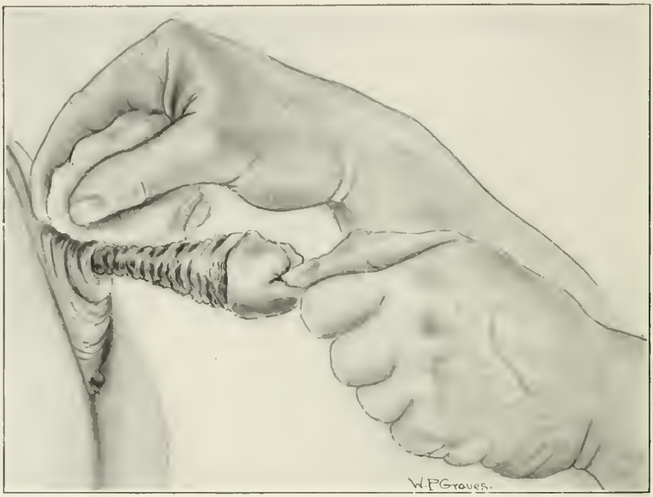

FIG. 431.—High Amputation of the Cervix. The drawing represents the method of stripping the cervix by means of a pledget of gauze. It also shows how the diameter of the cervix rapidly diminishes as the stripping advances. (Original.)

It is necessary to use chromicized catgut on account of the difficulty that would attend the removal of any non-absorbable suture material. There is always a tendency to sepsis following operations for high amputation of the cervix. Hence the necessity of exercising great care, not only in the matter of approximating the raw surfaces, but also in that of utilizing antiseptics before, during, and after the operation. Douches of corrosive-sublimate solution (1:5,000) or of sterilized water should be given twice daily (beginning on the day following the operation) for at least three weeks.

Low Amputation of the Cervix.—Low amputation of the cervix is commonly indicated in cases in which, on account of the mutilating result of lacerations, a satisfactory plastic operation of the ordinary kind is out of the question.

Steps of the Operation.—A circular incision is made and the tissues are stripped back from the cervix for only a short distance. The cervix is then amputated, and the cervical mucosa is united with the vaginal mucous membrane exactly in the manner described for high amputation. Subsequent treatment should be carried out in the same way as in high amputation.

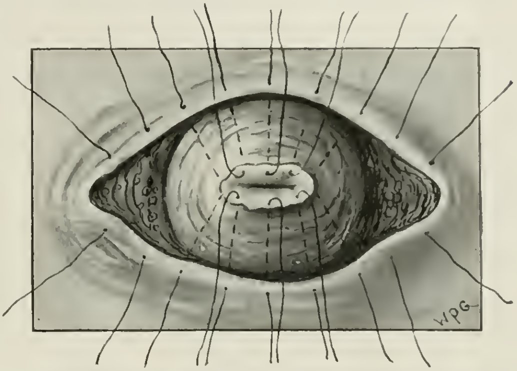

Fig. 432.—Hegar's Method of Placing the Sutures After a High Amputation of the Cervix. The three middle sutures, above and below, pass through the mucous membrane of the cervix and the mucous membrane of the vagina. The three lateral sutures pass completely across from one edge of the vagina to the other, and dip deeply into the lateral tissue so as to control hemorrhage.

Operations for Repair of the Lacerated Perineum. In order to repair properly the perineum lacerated by childbirth it is necessary to understand definitely the anatomical lesions of this injury. The anatomy of the female perineum is complicated and difficult to carry in mind, but, fortunately, in the tears of childbirth only a part of the perineal muscles are ruptured, and if this portion of the perineal structure is thoroughly understood, the rest may be practically disregarded.

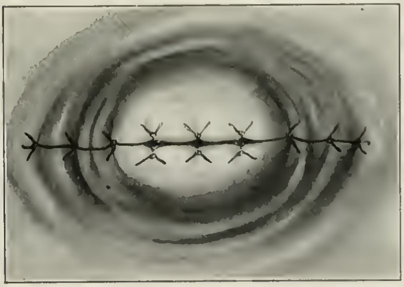

Fig. 433.—High Amputation of the Cervix; Hegar's Method. The drawing shows the appearance of the parts after the sutures have been tied.

The chief structures involved in lacerations of the perineum are the levator ani muscles. Each muscle arises high up on the internal surface of the pubic ramus near the symphysis. From here the origin extends along the white line of the pelvis to the spine of the ischium; the fibres then converge in a fan-like manner and meet the muscles of the opposite side in the median line, extending from the level of the hymen to the coccyx. The muscle of each side is divided into three parts, the anterior, middle, and posterior. The portions lacerated in an ordinary tear of the perineum include only the anterior and middle fibres. Fig. 434 shows in a diagrammatic way the fibres of the levator ani muscle that are usually lacerated. The anterior fibres are intimately associated with the wall of the vagina, and are very important in holding it up in the normal position posteriorly. The middle fibres are attached to the wall of the rectum, and are of great importance in supporting the lower end of the rectum in its normal position. The muscles of the two sides meet each other at the point *H*, leaving a V-shaped space between on the posterior wall, behind which lies the rectum. At the point of convergence the two levator muscles decussate freely with the fibres of the transversus perinei muscle, and it is this union with the transversus perinei which essentially forms the so-called perineal body.

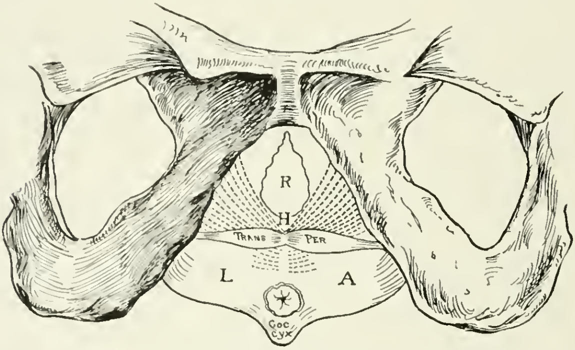

Fig. 434.—Diagram Showing the Fibres of the Levator Ani Muscles which are Usually Torn in Laceration of the Perineum. These fibres are the ones located, in the diagram, between the letter *H* and the anal orifice. The transversus perinei muscle is represented as thickened where it receives fibres from the levator ani muscles. The normal position of the vaginal outlet (*R*) is shown. *H* represents the lower border of the hymen. *L*, *A* represent the portions of the levator ani muscles which are usually left intact after rupture of the perineum.

When a laceration of the perineum takes place the following things usually happen:—The anterior and middle fibres are ruptured, either partially or completely, on one or on both sides; and, instead of the firm continuous structure seen in Fig. 434, there results the loose, torn, flabby structure represented in Fig. 435. Besides the longitudinal rupturing of these two muscles, they are also rent apart at their median convergence along the raphe from *H* toward the anus. The transversus perinei is also torn apart in the median line, and the two bellies lie sagging and useless, as represented in Fig. 435. It will thus be seen that the support given to the posterior wall of the vagina and the walls of the rectum by the anterior and middle fibres of the levator ani muscles is now lost, and that also the firm elastic muscular external support given by the blending of the transversus perinei and levator ani muscles is now lacking. Therefore the posterior wall of the vagina and the lower portion of the rectum, having no longer adequate suspensory support, tend to push forward and outward. Fig. 435 shows diagrammatically the anterior and middle fibres of the levator ani muscle lacerated away from their vaginal and rectal attachments, while at the same time the transversus perinei muscle is separated widely at the median line. The point *H*, in Fig. 434, has here entirely disappeared. The point *R* of Fig. 434 has sagged down to the point *R* of Fig. 435. The opening of the vagina which was formerly at *H* is now stretched out and widened in the form of the dotted line shown in Fig. 435.

If these facts be borne in mind, it will be easy to understand that, in order to restore the function of the lacerated muscles, it is necessary, first, to unite as far as possible the lacerated ends of the levator ani muscles, in order to restore them to their previous length; secondly, to attach the fibres of the levator ani muscle to the lateral wall of the rectum; thirdly, to bring the separated muscles to their normal point of convergence at *H*; and, fourthly, to bring about the union of the separated bellies of the transversus perinei muscle with their decussating levator ani fibres in the position which they normally occupy in the median line. An operation which can accomplish these four objects is one which restores the perineal muscles completely to their normal anatomical position and to their function. The only operation which completely fulfils these requirements is that devised by Emmet, and is so incomparably superior to other operations that serious consideration will be given only to this method. The majority of other operations consist of a median denudation, and do little more than to restore the so-called perineal body, namely, the point of union of the levator ani muscles with the transversus perinei. Such operations neglect the most important part of the tear, namely, the rending of the anterior and middle fibres of the levator ani muscles, and their separation from the wall

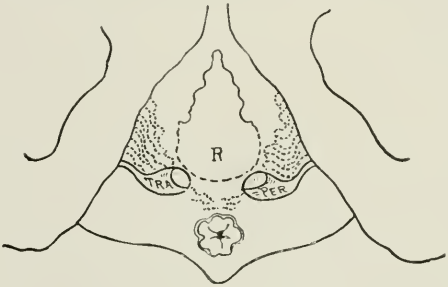

Fig. 435.—Diagram Illustrating the Way in which the Levator Ani Muscles are Torn in Laceration of the Perineum. They are not only rent longitudinally, but are also torn away from their attachment to the side walls of the rectum. The two muscles are also separated widely from their median convergence. The transversus perinei muscle is here, for the purpose of illustration, represented as having distinct bellies. These bellies are formed by the merging of the fibres of the transversus perinei and the bulbo-cavernosus into the levator ani muscles. The anatomical appearance of this union of muscles is not defined in nature as it is in this diagram, but the mechanical effect of such union is here correctly represented.

of the rectum. These lesions can best be repaired by denuding the vagina according to Emmet's method, and thus exposing the lateral sulci. The operation of Holden, which consists of a median denudation, secures the levator ani muscles on each side and anchors them firmly by buried sutures to the median line. This may be effective where there is considerable laceration of the levator muscles and separation from the rectum, but it does not restore the parts to their normal anatomical relations.

In unusual cases the rupture of the perineum is only in the median line, sometimes extending completely through the sphincter muscle and into the rectum, but without any laceration of the lateral attachments of the levator muscles. In a case where the rupture is only in the median line and does not extend through the sphincter, the most useful operation is the operation of Hegar, which consists of a triangular denudation, the three angles coinciding with a point on the posterior wall of the vagina and with two points directly beneath the openings of Bartholin's glands. Sutures are passed transversely, and the result is the complete restoration of the separated median raphe of the perineum. The operations of Dudley, Goffe, and Pryor are similar to this operation in principle.

Finally, it should be remembered that the support of the perineum is essentially a muscular one. This can be appreciated by the examination of the normal unlacerated perineum, which acts as a firm but entirely elastic sphincter to the vagina. A properly repaired perineum should possess the same firmness and elasticity, and the posterior portion of the vaginal entrance should hug closely the anterior wall, so that the introitus, instead of being a circular opening, should be a transverse slit. Such a result can be accomplished only by restoring the perineal muscles to their normal relations.

Any operation which results in the formation of scar tissue and a non-elastic introitus should be considered as bad surgery.

Indications for Operation.—In practically every case of labor there ensues a certain amount of relaxation of the vaginal outlet. This relaxation may be due to an actual laceration of the parts, which is perfectly evident at the time of delivery and which should be repaired by the attendant at the time; or it may be due to a stretching of the perineal muscles, from the effects of which they do not recover their former elasticity. Actual rupture of some of the important fibres of the levator ani muscle may occur without external evidence. There are two kinds of cases in which an operation is indicated:—first, those in which the symptoms demand relief; and, second, those in which, although there may be an absence of all symptoms, the laceration of the perineum is so great that it may act as a starting-point for a future gradual giving way of the pelvic floor.

The symptoms which ordinarily call for surgical intervention are a constant sensation of bearing down and a general sense of weakness in the pelvic organs. Such patients become quickly tired when on their feet, and there exists a general physical depression, with various forms of nervous invalidism. Dragging pains in the loins are common in stout subjects and are often referred by the patients themselves to their ovaries or kidneys.

In order to determine the mechanical indications for operation a thorough examination of the perineal muscles is necessary. Mere inspection of the external genitals is misleading, as frequently an extensive rupture of the fibres of the intrinsic muscle may exist without affecting the outward appearance of the perineum. With the forefinger inside the vagina and the thumb on the external perineum, the perineal body, or junction of the levator ani with the transversus perinei muscle, should first be investigated. In the unruptured perineum this body is firm, thick, and elastic, and hugs closely the anterior vaginal wall so that the introitus is a horizontal slit. There is always after childbirth a certain amount of separation of the muscles in the median line. In severe lacerations the muscles retract widely and can be felt as indefinite masses of tissue lying close to the pubic bones. It may happen that the external skin is lacerated very little or not at all by a labor which nevertheless causes considerable separation of these muscles; or, if an external laceration did occur, it may have been only superficially repaired at the time of labor. In these cases a thin septum exists between the vaginal introitus and the sphincter, and this septum, though of good appearance externally, has no supporting power whatever.

Having determined the condition of the median perineal body, the surgeon should explore, with the forefinger and thumb in the same position as before, the levator ani muscles up to their pubic attachments on each side. If these muscles are unruptured their edges can be felt firm and rounded, while the inside of the vaginal canal, when pressed upon, feels smooth and unbroken. If the anterior and middle fibres of the levators are ruptured, well-marked deep sulci can be felt extending in diverging directions, from the centre of the introitus to the points of attachment of the levators to the pubic bones. If the rupture has occurred on only one side, only one sulcus will be felt. The muscles feel flabby and loose, or, in severe cases, they may not be palpable. As a final test of the amount of laceration, the two forefingers should be hooked into the introitus and pulled sharply downward and outward. The patient is requested at the same time to press down as in the act of defecation. In severe cases of laceration or relaxation the rectum will roll prominently into view.

In determining the advisability of operation it should be borne in mind that a separation in the median line may exist externally without laceration of the levators internally. Such a condition does not ordinarily threaten much the future integrity and usefulness of the pelvic floor. If, however, the levators are impaired internally to any marked extent, operation is indicated.

Operative Technique.—Instruments.—The special instruments needed are: a pair of bullet forceps, several sharp-pointed and long-handled tenacula, a pair of mouse-tooth forceps, and right and left Emmet's scissors.

Suture Material.—Chromicized catgut, number 1, is the best suture for the internal vaginal stitches, and silkworm gut for the external ones.

Steps of the Emmet Operation for Lacerated Perineum.—The labia minora having been retracted by the assistants, there is first selected, on the posterior wall of the vagina, a point which, when grasped by a pair of bullet forceps and approximated to the anterior wall, reaches the junction of the anterior and middle thirds of the urethra. When this point of the posterior wall is drawn up to the anterior wall, enough tension should be placed on the posterior wall to reduce the rectocele, care being taken not to draw it so tightly as to pull forward the cervix and thus retrovert the uterus. After this point on the posterior wall has been chosen, a tenaculum should be placed just beneath and just inside the opening of Bartholin's gland on the left side. The tenaculum should then be drawn sharply outward, and at the same time the bullet forceps attached to the posterior wall should be drawn strongly in the opposite direction, as shown in Fig. 436. By this procedure there is exposed a triangular area which has, for its three angles, the following points: the point on the posterior wall, the point just below Bartholin's gland, and the point of the attachment of the vagina to the pubic arch. This last point, which is the apex of the triangle, is not always at first apparent, but should be searched for by picking up the vaginal wall with a pair of mouse-tooth forceps. This point varies in its position considerably, according to the amount of laceration sustained by the levator ani muscles. When the point has been selected, it should be caught by a tenaculum and held by the assistant. With the three angles of the lateral triangle thus held, the edges are brought into definite prominence and the denudation should be begun along these edges with a pair of Emmet's scissors. By keeping the tenacula at the angles of the triangle,—in other words, by keeping the landmarks constantly in view,—the surgeon will experience no difficulty in carrying on the work of denudation very rapidly. This method of denudation is more rapid and more accurate than that of first outlining the triangle with a sharp scalpel, which is the plan recommended in many of the text-books. After the triangular area on the left has been denuded, a similar area on the right side should be denuded. These two lateral triangles are not always perfectly symmetrical, on account of the difference in the amount of lateral tear which often takes place on the two sides. When the lateral areas are denuded, the bullet forceps in the posterior wall is drawn strongly upward in a perpendicular direction, while the tenacula at the sides of the two Bartholin's glands are drawn sharply outward, as shown in Fig.

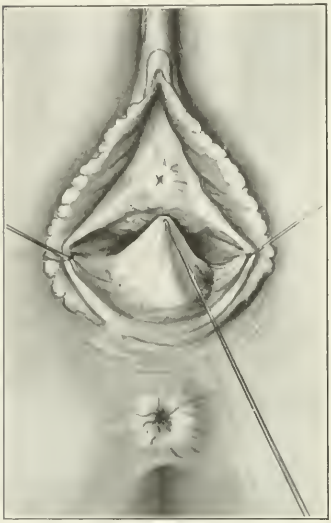

FIG. 436.—Preliminary Steps in the Operation for the Cure of a Lacerated Perineum. Tenacula are inserted just below and internal to the openings of Bartholin's glands and drawn apart to expose the field of denudation. There is then selected, on the posterior wall of the vagina, a point which, when approximated to the anterior wall, will be in relation with the junction of the middle and anterior thirds of the urethra. This point represents the end of the central tongue left by the denudation of the lateral sulci by Emmet's method.

436. This exposes a new triangle, which includes the so-called external perineum. This area is now denuded, great care being taken to make the line between the two openings of Bartholin's glands smooth and even. This line very rarely extends as far out as the skin, but in ordinary cases it should be kept well within the tender modified membrane which covers the entrance to the vagina. The denudation of this external portion of the perineum is of far greater importance than is often realized, because the accurate approximation and the future smooth union of the edges are very necessary for the eventual comfort and well-being of the patient, as will be shown later.

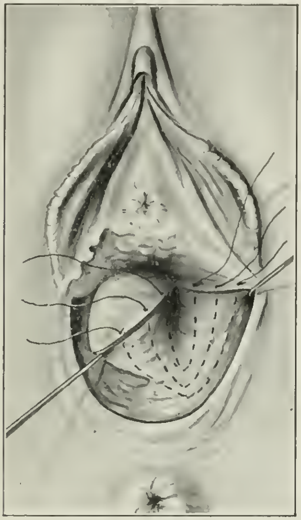

Fig. 437.

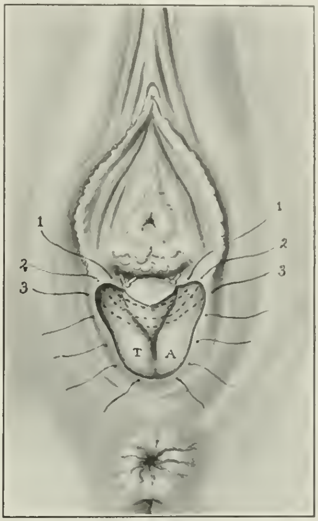

Fig. 438.

Fig. 437.—Second Stage of the Operation for the Cure of a Lacerated Perineum. The drawing shows the entire internal and external perineum denuded by Emmet's method. The first stitch, beginning at the internal lateral angle of the denuded area, is carried well out toward the external perineum, and returns again to the angle of the denuded part. The last stitch is shown curving around toward the median line of the rectocele, so that when drawn taut it will gather in as much as possible of the slack tissue contained in the rectocele.

Fig. 438.—Third Stage of the Operation for the Cure of a Lacerated Perineum. The internal lateral angles of the denuded area have been sutured and the knots tied. The drawing shows the writer's method of placing three crown sutures instead of one, as is usually employed. The ends of the separated transversus perinei muscles (*T*, *A*) are shown, and so also is the method of placing sutures so as to approximate them. It is to be observed in the drawing that the posterior wall of the vagina, after the lateral sutures have been tied, will approximate the anterior wall.

The denudation of the external and two lateral triangles having now been completed, the important stage of inserting the internal lateral sutures is reached and it is upon the correct placing of these sutures that the final success of the operation largely depends. Beginning on the left side, the surgeon exposes the lateral triangle in the manner shown in Fig. 437. The suture, consisting of number

1 chromicized catgut in a full-curved needle, is started at the internal angle of the denuded area. It is carried boldly into the tissues, directly downward and outward toward the vaginal outlet, as far as the external perineum. It is then brought out in the sulcus of the denuded area, and carried directly back again toward the internal angle, superficially through the tissues of the rectocele, and is brought out through the mucous membrane of the vagina at a point opposite to that at which it started. The suture thus takes a V-shaped course, as is shown in Fig. 437. Two or three other sutures are then placed in the lateral denuded area in exactly the same way as is shown in the figure. In case of a large bulging rectocele, the suture, while passing through the tissues of the rectocele, should be carried around as much as possible toward the median line, in order that the final suture may be placed directly in the median line of the rectocele. It will be seen, after these sutures are drawn tight, that the slack tissues of the rectocele have been drawn completely up into the vagina, and that the entire sagging perineum has also been brought snugly up and anchored to the firm unyielding support given by the attachment of the vagina to the pubic arch—a point which corresponds to the apex of the triangular denuded area. On the right side the sutures are placed in exactly the same way. None of the sutures should be tied until all have been correctly placed.

The writer hopes that, by means of the above description and of the accompanying drawings, he has succeeded in emphasizing sufficiently the great importance of the mechanical principles involved in the method of placing these sutures; a point which, though made clear by Emmet himself in his original description of the operation, is frequently neglected in the more recent descriptions and drawings.

Sutures, either interrupted or continuous, which are passed from side to side, may leave the perineum in exactly the same sagging condition in which it was before the operation. The use of the continuous suture in the lateral sulci cannot be too strongly condemned. When all the sutures have been tied on both sides,the appearance of the perineum should be that which is depicted in Fig. 438. It will be seen, first, that the rectocele has completely disappeared, being drawn tightly up into the vagina; second, that the posterior wall is approximated to, and closely hugs, the anterior wall, as it does normally in the unruptured perineum; third, that the separated bellies formed by the transversus perinei and levator ani muscles (*T A*, Fig. 438) are brought together in close approximation; fourth, that the perineal body, instead of sagging down toward the anus, is now full and round, and drawn up toward the vagina in the position which it normally should occupy.

Placing of the External Sutures.—The essential part of the operation has already been finished by the placing of the internal stitches. The object, in placing the external stitches, is merely to approximate the edges of the remainder of the wound, and to draw into close union the bellies of the transversus perinei made by their union with the levator ani muscles. This stage is, however, one of great importance, because a perineum, though it may restore perfectly the lost support, may yet be left externally in such a ragged and irregular condition as to cause continuous annoyance and distress to the patient, especially in the function of coition. It is therefore important that the operator, bearing in mind the natural contour of the introitus, should exercise his greatest skill in performing this part of the operation.

Before placing the stitches the surgeon should trim the edges of the denuded area so as to give it a symmetrical shape, for, if this is not done, it is impossible to make the final wound perfectly smooth. The practice of closing the external perineum rapidly and at haphazard, trusting to nature finally to make it smooth, is unsurgical and will often render the result a failure. The method of placing the sutures, described here, is one which has been adopted by the writer because he believes that by it a smoother, firmer introitus is secured than by the method usually recommended. Three crown sutures are first placed at the top, as shown in the figure. These sutures pass from side to side and include the small tongue which protrudes on the posterior wall. It will be noticed that, at the points corresponding to the openings of Bartholin's glands, the denuded area is given a rounded instead of an angular contour, as is usually done. In this way the introitus is made more funnel-shaped. After the three crown sutures have been put in place, the lateral sutures are introduced, one after the other, down to the end of the wound, being carried deeply into the bodies of the transversus perinei and levator ani muscles. All the external sutures are then tied with great care as regards the approximation of the edges. The best method of leaving the sutures is to clamp them in perforated shot close to the knot. After the operation is finished it is always well to dilate the sphincter, for the purpose of facilitating the escape of any gas that may accumulate in the rectum, and of thereby increasing the patient's comfort in the first hours of convalescence.

After-Treatment.—The patient should be placed in bed with a roll under the knees, and the knees should be kept tied for twenty-four hours, or longer if the patient is restless. Douches of sterile water or of corrosive sublimate solution (1 : 5,000) should be given on the day following the operation, and then twice daily until the external perineum stitches are removed (on the ninth or tenth day). After this date a daily douche should be given, and this practice should be maintained during the remainder of the patient's stay in the hospital. Subsequently the patient should herself continue to use the douche at home as long as there is any vaginal discharge. This vaginal discharge, which is probably caused by the slight irritation of the catgut sutures before their complete absorption, may possibly persist for a few weeks. If neglected, the discharge is apt to become irritating and to cause considerable delay in the patient's complete recovery.

Steps of Holden's Operation for Lacerated Perineum.—The operation for lacerated perineum devised by Holden is one which is useful in some cases. Among its leading features may be mentioned the complete dissection of the upper portions of the levator ani muscles and the bringing of the two lateral bellies together in the median line as high up in the vagina as possible. In this way a sort of rampart is created which pushes back the protruding rectocele. The operation, however, creates an artificial relationship between the levator ani muscles and the rectocele, and makes it impossible to restore the lacerated perineum to such a natural form as can be done by Emmet's method. The technique of the operation is as follows:—A central denudation is made on the posterior wall as high up toward the cervix as the relaxed condition of the parts will permit. The denudation can be made by first splitting the vaginal mucous membrane and then either pushing it to one side with a blunt instrument or separating it from its attachments by the use of scissors, until the bellies of the levator ani muscles are thoroughly exposed. The external portion of the perineum is denuded in the usual way, the denudation, however, being carried more deeply. The wound is closed by catgut sutures, the first ones being placed at the upper angle of the denuded area. The first few stitches merely approximate the opposite surfaces of the posterior vaginal mucous membrane. As soon as a point is reached where the diverging fibres of the levator ani can be drawn together

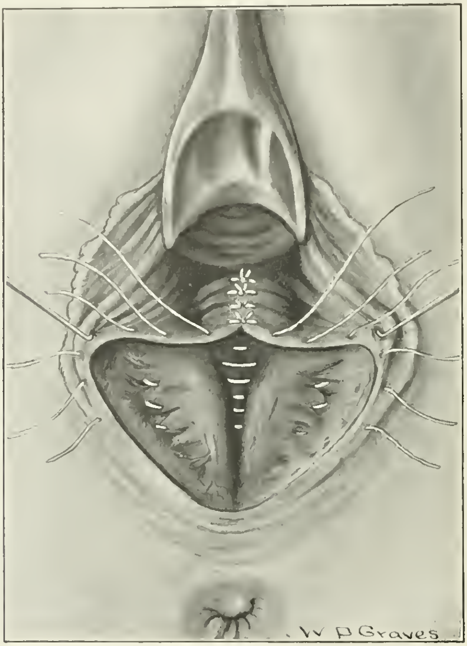

Fig. 439.—Holden's Operation for Lacerated Perineum. The bellies of the levator ani muscles are exposed by deep dissection. The sutures represented as tied are of catgut. The untied sutures are of silkworm gut and pass deeply into the muscles, so that, when the sutures are tied, the two diverging muscles are drawn into contact in the median line. The sutures are here represented as placed transversely instead of in the form of a figure-of-8, as in Holden's original method. (See Kelly's "Operative Gynæcology," Vol. I.)

in the middle line, silkworm-gut sutures should be used. They should be passed deeply into the muscular tissue, so that, when the sutures are tied, as broad surfaces as possible of the two muscles may be brought into approximation.

Holden's method of placing the sutures is in the form of a figure-of-8; his object being to insure the approximation of broad surfaces. The writer, however, finds that deep transverse sutures accomplish the result sufficiently well and are much more easily placed and removed. Fig. 439 depicts the placing of the sutures by the writer's method.

Repair of Complete Laceration of the Perineum through the Sphincter Ani.—In operating for complete laceration of the perineum through the sphincter ani, it should be remembered that the laceration is in every way like an ordinary laceration, excepting that the median rent is more extensive and includes a rupture of the sphincter ani muscle, while the laceration or stretching of the lateral fibres of the levators is usually less. It is therefore necessary, in repairing the perineum, to carry out the same principles that have already been laid down. The operation itself presents no special difficulties, but the exposure of the rectum materially increases the danger of sepsis, the ultimate effects of which may be to destroy the results of a skilful operation or even to imperil the life of the patient. Extraordinary precautions must therefore be observed in the preliminary treatment, in maintaining asepsis at the operation, and in conducting the after-treatment of the wound and the regulation of the bowels.

Diagnosis and Indications for Operation.—The diagnosis of a complete tear is usually suggested by the history of incontinence of fæces following labor. The usual appearance of the anus shows that it has lost its circular rotundity. The upper half is flattened out into a horizontal bridge of tissue. At each side of the orifice is a well-marked dimple which corresponds to the lacerated end of the sphincter muscle. The forefinger inserted into the anal opening does not encounter the usual elastic tension of the sphincter muscle, and it will be found that the transverse bridge is composed either of a non-elastic scar tissue or merely of a septum of skin. Where the laceration has been more severe the transverse bridge may be entirely lacking and the rectal mucous membrane exposed. The rectum may be exposed only for a short distance, its distinctive red mucous membrane being slightly everted, or it may be ruptured as high up as close to the mouth of the cervix.

In all cases where fæcal incontinence is present the operation for complete laceration should be performed. It occasionally happens that the natural repair following a severe laceration at childbirth causes a firm cicatricial bridge to form between the ruptured ends of the sphincter muscle, and in consequence fæcal continence is maintained. If the function of the sphincter is good it is not necessary to operate on the sphincter muscle and thus subject the patient to the unusual risk which operations for complete laceration entail.

Preliminary Treatment.—For four or five days before the operation the patient should receive at night some cathartic which will surely produce one or more movements on the following day. She should be fed on a light nourishing diet without milk. Two days before the operation calomel should be given in divided doses. On the morning before, on the afternoon before, and on the morning of the operation, high enemas should be given, the last one to be followed by a cleansing rectal douche until the water runs clear.

The preparation of the vagina should be carried out as described on page 580. When the patient is under the influence of the anaesthetic and just before the operation begins, the vagina and the external parts should again receive a scrubbing, and in addition the rectum should be scrubbed with green soap by means of a small gauze sponge attached to a sponge-holder. A strip of gauze should then be packed into the rectum by means of a Davenport tampon-extractor, and it should be removed when the operation is finished.

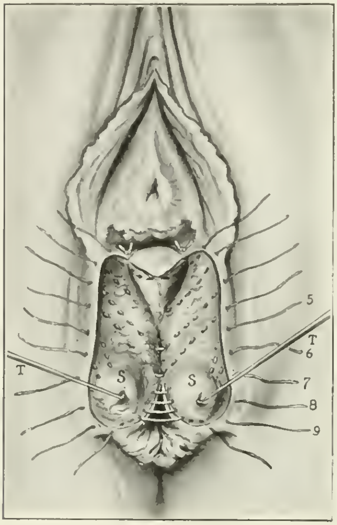

FIG. 440. – Complete Laceration through the Sphincter Ani. The drawing shows the internal portion of the perineal operation finished, with sutures tied. The external perineum is denuded down to the anus and the ruptured ends of the sphincter ani are exposed. *T, T*, tenacula inserted into the ruptured ends of the sphincter, *S, S*. The method of placing the external sutures is shown. Sutures marked 5, 6, 7, 8, pass deeply through the sphincter muscles and just escape the mucous membrane of the rectum in passing across.

Steps of the Operation.—The operation for complete tear of the perineum is performed in the same way as that for an ordinary laceration, excepting that the dissection of the skin from the underlying parts is extended for some distance upon the buttocks and also close up to the sides of the sphincter ani, so as to expose the ruptured ends ot this muscle. Within the vagina the lateral triangles of the perineum should be denuded and the lateral sutures placed in the manner described above. The external denudation should be carried out in the following manner:—As a first step, the area to be denuded is mapped out with a sharp scalpel. To accomplish this, a shallow incision is carried directly down from the opening of Bartholin's gland to one side of the anus and just above the small dimple which always indicates the end of the ruptured muscle. A second incision is then carried directly across to the opposite side. This incision passes just above the dimple that shows the other end of the ruptured muscle, and is then carried from this point to the opening of the other Bartholin's gland. When the area thus outlined has been denuded it presents the appearance shown in Fig. 440.

The suture material used in closing the external perineum may be silkworm gut or silver wire, preferably silkworm gut. Crown sutures are placed as in the ordinary operation. The sutures are then carried through the lateral muscles down to the rent in the mucous membrane of the rectum, as shown in

Fig. 440. The ruptured ends of the sphincter muscles should be partially dissected out, then grasped and brought into prominence by means of a tenaculum. The lower sutures should be carried deeply into the ends of the muscle in such a way that, when tied, the muscle ends will be brought into perfect approximation. The sutures should then be tied or twisted with great care, and the packing in the rectum removed.

Another type of operation (Fig. 441) for the repair of the complete laceration of the perineum was first introduced by Dr. J. Collins Warren in 1878, and later developed by Dr. Howard A. Kelly. By this method, which is called the apron method, the tissue which lies between the vagina and anus, and which is cut away in the operation first described, is dissected off and turned down over the anus, the thin septum above the anus being used as a hinge. In this way the rectum and anus are shut off from the operative field. When this has been done the ends of the sphincter muscle are dissected out and joined together by buried catgut sutures. The wound can then be closed by silkworm-gut or wire sutures, the edges of the apron being brought together and sutured with silk or fine catgut, so as to turn it into a tab which projects somewhat over the anal orifice.

This operation is an excellent one, but presents no great advantages over the operation first described.

In adopting any method for the repair of a complete tear the surgeon should remember that sutures are always to be tied on the outside and never within the rectal or anal cavity. Sutures should always be placed in such a way that they will not be exposed to the rectal surface.

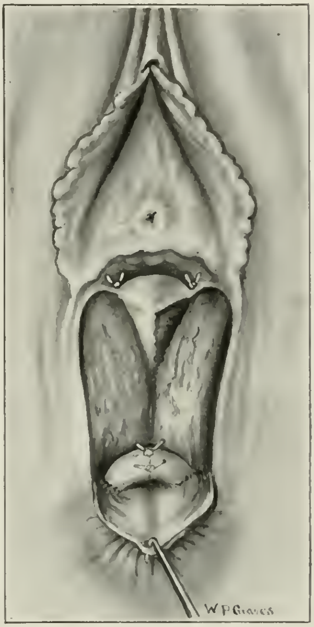

FIG. 441.—Apron Method for Complete Tear of the Perineum. The sketch represents the completed denudation of the lateral sulci and the external perineum. The "apron" is the external portion of the perineum dissected off and turned down over the anus. The ends of the lacerated sphincter are shown brought together and tied by catgut sutures which will be buried when the sides of the wound have been closed. The "apron" is completed by approximating its sides and then sewing the edges together. Any excess, which might lead to sloughing, may be trimmed away.

After-Treatment.—The classical treatment for cases of complete tear, and one which is recommended by most of the best authorities, is to keep the patient's bowels closed for nine days after the operation, only a light liquid diet without milk being given, and tincture of opium ♏ iij. being administered three times daily. Stitches are removed on the ninth day, and the bowels are moved on the following day. Then, for one week, a cathartic is given each night, while an enema of sweet oil (℥ iv.) is injected into the rectum in order to lubricate the dejection which is expected the following morning. Another plan is to move the bowels by means of castor oil on the third day after the operation. Immediately after the dejection which occurs as a result of this cathartic, the rectum may be carefully irrigated through a small tube not larger than a female catheter. A return-wash female catheter is a good instrument to use. This catheter should be passed through the sphincter only by an experienced person. Where expert care is not available, it is better to omit the rectal irrigation altogether. The castor oil catharsis each night may be continued for ten or twelve days, to be succeeded by a less drastic purgative. During this period the patient should be kept on an ordinary nourishing diet, moderate in amount, and without milk. The writer prefers the method of keeping the bowels closed for at least nine days.

Operations for the Cure of Cystocele.—Cystocele, as its name implies, denotes a protrusion of the bladder into the vaginal opening, and is usually produced by the vaginal relaxation which results from a severe laceration. The most important etiological factor in the production of cystocele is the deeply lacerated and relaxed perineum, although in rare instances it is possible for cystocele to occur in nulliparous women of generally relaxed muscular tone.

The operative treatment of cystocele depends on the extent of damage that has been done to the natural supports of the vagina and pelvic organs, and it is therefore convenient to classify the lesions into two types, namely: Simple Cystocele, and Cystocele with Prolapse.

Simple Cystocele denotes that there is a weakening and protrusion of the anterior vaginal wall, but that the lateral attachments of the vagina to the pubic arch have maintained wholly or in part their normal integrity.

Cystocele with Prolapse denotes that the lateral attachments of the vagina to the pubic arch have given way, and, as an inevitable consequence, there is in conjunction with the cystocele a greater or less amount of prolapse of the uterus.

Cases of simple cystocele may be cured permanently by a plastic operation on the anterior wall of the vagina which takes advantage of the lateral pubic attachments. Cystocele with prolapse, on the other hand, can rarely be permanently cured by such an operation alone. Treatment of this condition will be discussed under the heading of Prolapse.

Indications for Operation.—The symptoms of simple cystocele consist usually of disturbances of micturition, such as pain, frequency, and inability completely to empty the bladder. The patient usually is conscious of the protrusion and in most instances considers it a falling of the womb. Cystocele should always be treated by operation if the consent of the patient can be gained, and if her physical condition warrants the operation. Palliative measures, such as the use of pessaries, effect a cure only in rare instances, though they may frequently give temporary relief. As a rule, a pessary which is effective in reducing a cystocele tends also still further to relax the vagina.

Operation for Simple Cystocele.—The most important thing in an operation for the relief of a simple cystocele is to reduce the too redundant vaginal tissue to such an extent as shall restore the anterior vaginal wall to its normal contour, and shall restore it in such a way as to create a wall of tissue firm enough to resist the encroaching pressure of the bladder. The tissue of the anterior vaginal wall thus restored does not of itself possess sufficient power permanently to withstand the abdominal pressure of the bladder and overlying organs, and must in all cases be reinforced by a careful repair of the perineum, which will result in a thick and firm perineal body, that hugs closely the anterior vaginal wall. If these two operations are properly performed and if primary union of the wounds follows, the surgical treatment of simple cystocele should practically always result in permanent success.

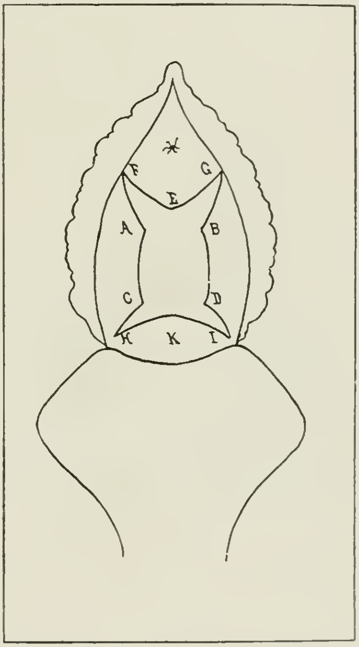

Fig. 442.—Diagram to Illustrate Graves's Operation for the Relief of Cystocele. (The explanation is given in the text.)

Numerous and ingenious operations have been devised for correcting the lesion. The operation here described is one employed by the writer; it combines and modifies principles which have been used in several other operations. The advantage claimed for this operation is, that it is possible by it to reduce the slack tissue in every direction, so that the final appearance of the anterior vaginal wall is entirely normal and completely free from troublesome protrusions, which may act as starting-points for a new hernia, or as wedges which may eventually stretch the freshly repaired perineum.

The steps of the operation are as follows:—Two points are selected on each side of the cystocele, about one-half inch from the lateral creases. These points, when drawn together —*A* to *B*, and *C* to *D* (Fig. 442)— sufficiently reduce the cystocele and at the same time do not exert undue tension on the lateral flaps. With these four points as corners, a rectangular area is then denuded. A point is next selected on the urethral tab *E*, which, when drawn down to the approximated points *A* and *B*, completely reduces the urethrocele. The area included between points *A*, *B*, *E*, *F*, and *G*, is denuded. *F* and *G* represent two deeply set dimples, which are always present nearly on a level with the meatus. The denudation of the angles *H* and *I* (two points at the sides of the cervix) is made in order to take out the slack caused by the approximation of *C* and *D*. It is not always necessary to denude these angles, and in such cases the denudation may be carried down to a point and the sides brought together as in the oval operation. This is shown in Fig. 442 by the dotted lines at the angle *K*. This form of denudation is sometimes an important procedure, for it assists in carrying backward a cervix which has a tendency to prolapse.

Great care should be exercised in making the outlines of the denuded area symmetrical, so as to gain perfect approximation of the edges; for it is by reason of the perfect manner in which the edges of the wound are approximated that sepsis is avoided and union by first intention secured.

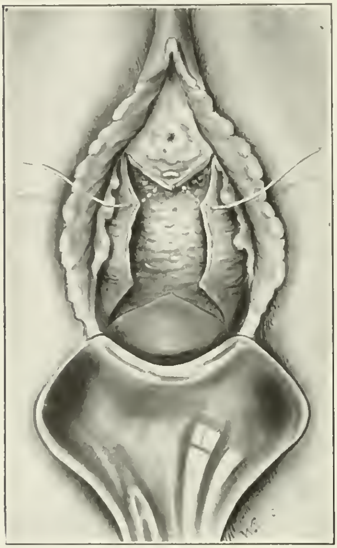

Fig. 443.—Graves's Operation for the Relief of Cystocele. The drawing shows the method of denudation and also the manner in which the upper stitch should be placed in order to secure good approximation of the angles.

Fig. 443 shows the cystocele after being denuded. The method of placing the important crown stitch is also shown.

Fig. 444 shows the method of placing the other sutures.

Fig. 445 gives the appearance of the wound when the sutures have been tied. The anterior wall should, when the operation is finished, be concave. Where there is considerable protrusion of the bladder in the upper portion of the vagina, such as obtains in cases of prolapse with loss of attachment of the vagina to the pubic bones, the denudation of the upper angles may be carried well around the cervix toward the posterior wall. This is shown by the outline of the denuded surface in Fig. 444.

After-Treatment.—The most important thing to care for, in the convalescence of patients who have been operated on for cystocele, is the prevention of the tension which the bladder, when filled with urine, exerts upon the stitches. It is therefore a good rule, and one which should be rigidly followed, to catheterize the patient every four hours for the first twenty-four hours, every six hours for the second twenty-four hours, and every eight hours for the third twenty-four hours. Catheterization should be kept up until the patient is able to void her own urine, which she should be encouraged to do in order to avoid the possibility of cystitis which is liable to follow prolonged catheterization.

Daily douches of sterile water, or of 1 : 5,000 corrosive sublimate solution, should be administered. The use of corrosive sublimate most surely prevents the occurrence of sepsis, but it is necessary to exercise great care in giving corrosive douches after operations for cystocele, because the meatus is drawn somewhat into the vagina, and an inexperienced nurse is liable to introduce some of the solution into the urethra. Such an accident usually causes a painful urethritis or cystitis.

To secure the best results after a cystocele operation it is advisable to keep the patient in bed for three weeks, excepting where old age makes a protracted stay in bed constitutionally dangerous. When the patient begins to sit up she should be placed at once in a hard-bottomed chair. Sitting up in bed or on soft cushions allows the abdominal organs to press the repaired cystocele against a yielding surface and may in some instances be injurious to the final success of the operation.

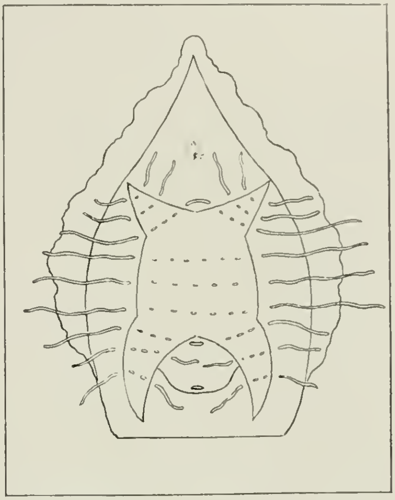

FIG. 444.—Diagram Showing Method of Placing Sutures in the Operation for Cystocele.

Operations for the Relief of Prolapse of the Uterus.—The term prolapse will be applied, in this section, to the condition in which there is a descent of the uterus in the axis of the vagina. This condition may exist in many different grades, from a partial or slight descent of the uterus from its normal horizontal plane, to one where the uterus completely protrudes from the vaginal outlet. The prolapse may in the same patient have different grades, depending on whether she is standing or lying down, or oftentimes on her general bodily health as regards the presence or absence of physical exhaustion or relaxation. In extreme cases of complete prolapse the protrusion of the uterus may be permanent.

Diagnosis.—The diagnosis of prolapse is of special importance in all operations for relaxation of the vaginal outlet, as in such cases a plastic operation will be eventually unsuccessful if the prolapse of the uterus is not repaired. The diagnosis should be made, first, with the patient lying on her back. With the examining finger in the vagina and touching the cervix, the surgeon requires the patient to press her pelvic organs down as in the manner of defecation. Slight grades of prolapse of the uterus can thus be easily detected, independently of the descent of the bladder or rectum. A digital examination, for the purpose of determining more accurately the extent of the prolapse, should also be made with the patient standing and with her legs slightly separated.

Etiology.—Prolapse is nearly always the result of childbirth and occurs most commonly in multiparæ of middle age. One severe labor may, however, produce a marked degree of prolapse, and such cases are occasionally seen in young women. Rarely, prolapse of the uterus may occur in nulliparous or unmarried women. This is more apt to be the case in women who have naturally a weak pelvic floor, especially if they are subjected to heavy manual labor. The rare condition of congenital hypertrophy and elongation of the cervix results eventually in prolapse, which may be severe.

Pathological Anatomy.—It is not within the province of this article to go into a full discussion of the pathological anatomy of prolapse of the uterus, as this involves the question of the most important supports of the uterus, a matter which is still a subject of debate among the best authorities. It is sufficient for our purposes to say that prolapse depends for its existence on a general giving way of the uterine supports, most important among which are the utero-sacral and utero-vesical ligaments, and the attachment of the vagina to the rami of the pubes. The integrity of this attachment of the vagina to the pubes is always impaired proportionately to the amount of prolapse, and can always be used as a safe guide to the nature and amount of repair which must be done for the cure of prolapse.

In almost all cases of descent of the uterus there is also a descent of the anterior vaginal wall and some portion of the bladder or urethra. This is accounted for by the fact that there is a thick solid body of connective tissue existing between the upper part of the vagina and the bladder. When, therefore, the uterus and vagina descend, the bladder is inevitably drawn down and a cystocele results. In many cases there is also present a rectocele, which is probably independent of the descent of the uterus. The connection of the uterus and upper part of the vagina with the rectum is one only of loose areolar tissue, and a descent of the uterus does not necessarily drag with it the wall of the rectum.

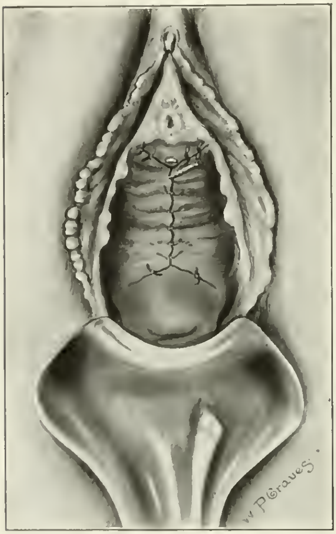

FIG. 445.—Graves's Operation for the Relief of Cystocele. The sutures have been tied.

It is important to recognize the fact that many cases of cystocele and rectocele exist with no prolapse of the uterus. In cases of cystocele without prolapse, the lateral attachments of the vagina to the pubes are always intact, and the cystocele must be regarded as a simple cystocele or hernia of the bladder into the weakened anterior vaginal wall. Where the lateral attachments of the vagina are intact cystocele can nearly always be cured in the manner described on page 609, and, where cystocele occurs in connection with prolapse, a plastic operation performed without in some way supporting the uterus will always end in either partial or complete failure.

The uterus, in cases of prolapse, is usually retroverted. Whether the retroversion precedes or follows the condition of prolapse is unimportant in its relation to the question of treatment. Considerable degrees of prolapse may occur with the uterus in a forward or even anteflexed position. The uterus may also be completely retroverted or retroflexed. In the great majority of cases, however, the general axis of the uterus corresponds with the axis of the vagina. Where there are extreme relaxation of the uterine supports and an atrophy of the uterine body the uterus may be very mobile, assuming different positions. Where the prolapse has been of long standing or is of considerable degree there are usually an hypertrophy and an elongation of the vaginal portion of the cervix. The hypertrophy of the vaginal portion is due largely to œdema as a result of the mechanical obstruction and the impairment of the circulation. In such cases the cervix is usually very much elongated and attenuated, and, as has been shown, may be as much as five or six inches long. Great congestion and hypertrophy of the body of the uterus may also exist, but more frequently, especially in women past middle age, the body of the uterus is small and atrophied.

Symptoms.—The symptoms of prolapse are a sense of general weakness and a constant bearing-down feeling. The patient usually notices first the descent of the anterior vaginal wall, and thinks that this is the uterus itself. There is nearly always some trouble with micturition, consisting of a frequency of desire and a sense of not completing the act. Irritability of the bladder and urethra is the rule, and this may be found in all grades from simple irritability, where there is nothing but a hyperæmia of the bladder or urethra, to conditions of severe cystitis. Defecation is frequently difficult and painful and can be accomplished only by holding back the protruding parts. Backache and general weariness are present. Where the protrusion of the bladder or uterus is constant so long as the patient remains on her feet, the exposed membrane becomes smooth, dry, and horny, being no longer bathed by the cervical secretions. The surface membrane is peculiarly liable to painful ulceration, which may result in foul and distressing discharges. Women frequently endure this condition for years and lead a pitiable existence.

Palliative Treatment.—In many cases, where proper surgical treatment cannot be secured, or where patients refuse a surgical operation, or when old age or constitutional diseases like diabetes, nephritis, or heart disease make an operation inadvisable, much relief can be given by the use of tampons and pessaries. No one form of pessary can be prescribed for these cases. Where slight prolapse exists with moderate cystocele Smith's hard-rubber pessary may be used. Where the prolapse is more advanced, or where there is less adherence of the vaginal wall to the rami of the pubes, it will be found necessary to employ pessaries which can take advantage of the rami of the pubes to hold them in place. The various ring forms of hard or soft rubber may then be tried. The so-called saddle pessary, placed transversely across the vagina so that the ends can engage the rami of the pubes, may frequently be used to great advantage. Stem pessaries, which depend, for the maintenance of their position, upon external straps or other apparatus, are not recommended by the writer, as they are especially liable to cause abrasions or ulcerations.

Surgical Treatment.—All cases of prolapse, even of the most extreme form, can be cured by surgical treatment. It may be said that an operation for prolapse always comprises two parts:—First, the repair of the relaxed vaginal outlet, which always includes perineorrhaphy, usually an anterior colporrhaphy, and, if necessary, a trachelorrhaphy; second, an operation to support the uterus at its normal level in the pelvis.

The plastic operations for repair of the vaginal outlet have already been described. The operations for restoring the uterus to its correct physiological level, though not belonging strictly to the sphere of this article, must nevertheless be alluded to in order to complete the consideration of the subject of prolapse.

It is the belief of the writer that the only structure which affords a reliable fixation point for the prolapsed uterus and upper portions of the vagina is the anterior abdominal wall. If use is made of this part of the body as a basis for suspension of the pelvic organs it will be found to furnish a firm elastic support. Such use causes the patient no pain and does not interfere with the action of other organs. The only objection is that such use may possibly prove a disturbing factor in subsequent pregnancies—a point which will be discussed later on. The operations by which the anterior abdominal wall may be used as a support for the pelvic organs in cases of prolapse are ventral fixation, fixation of the utero-sacral ligaments, vaginapexy, and abdominal colporrhaphy.

In cases of slight prolapse, where there is partial retroversion and where the basic uterine supports—for example, the utero-sacral and utero-vesical ligaments, and the pubic attachment of the vagina—are only moderately relaxed, a simple fixation may be performed. In slightly pronounced cases, where there is likelihood of a future pregnancy, the prolapse may be reduced by Mayo's modification of Alexander's operation. Where the prolapse is more pronounced and where it is accompanied by any considerable degree of cystocele, the support gained by the round ligaments is not sufficient, and some operation must be employed which will not only hold up the uterus but will also support the vagina. It can readily be seen by trial that a fixation of the uterus by its posterior wall serves to draw up the vagina and support it at a higher level. It will also be seen that the lower down the stitches are placed on the posterior wall of the uterus, the higher will the vagina be drawn toward the abdominal wall and the greater will be the support of organs which depend largely for their position on the integrity of the vaginal support. When, therefore, it is decided to operate for the relief of prolapse the point of fixation may be determined, after the abdomen is opened, by drawing up the uterus to the abdominal wall by means of double hooks inserted at such points that, when the organ is brought in contact with the anterior abdominal wall, the relaxed condition of the vagina is entirely overcome, without at the same time subjecting these parts to too great tension. The degree of such tension may be more accurately determined if an experienced assistant, with his finger in the vagina, gives information as to when the relaxation is properly overcome. It is usually sufficient in severe cases of prolapse and procidentia to place the fixation stitches through the back of the cervix at the junction of the utero-sacral ligaments. Where there is likelihood of future pregnancies, the danger of dystocia is greatly lessened if the fixation stitches are placed in the anterior instead of the posterior wall of the uterus. This method of anterior fixation is, however, not as effective as the posterior. Still greater reduction of the prolapsed vaginal wall may be attained by Baker's operation for vaginapexy. In extreme cases, especially where the uterine body is greatly hypertrophied, it is necessary to extirpate the uterus and then to perform an abdominal colporrhaphy, according to one of the following three methods —Polk's, or Crile's, or the writer's modification described below.

Operations for well-marked prolapse should practically always be performed under two etherizations. At the first operation the condition of the cervix should first be attended to. This will consist either of a repair of the laceration and eversion, both of which conditions are usually present, or of a high amputation for hypertrophy and elongation. (For the description of these operations see page 616 *et seq.*) A complete change of sterilized appurtenances of the operation should then be made in preparation for the abdominal section. The patient is put in the Trendelenburg position, and the appropriate operation for the reduction of prolapse of the uterus and vagina is performed. The patient is then put to bed and is kept there for the usual period of ten days or two weeks, when she is allowed to be up and about for several days. By this time a certain amount of relaxation of the vaginal tissues will have recurred, and consequently at the second operation, which should now be performed, it may easily be determined how much vaginal tissue is to be removed.

The second operation consists of an anterior colporrhaphy for reduction of the loose tissue of the anterior wall of the vagina, and for the greater support of the lower portion of the bladder. An extensive and thorough operation on the posterior wall, by the method of Emmet, then follows. In performing this operation attention must be particularly given to the restoration of the levator ani muscles, and to building up a thick, firm perineal body which shall hug closely the anterior wall and aid in the prevention of a recurring urethrocele and cystocele. The operation used is the same as that described on page 600, but, in the case of an elderly woman, the internal denudation may be made more extensive on the sides, and the calibre of the vagina much reduced. The denudation in such cases may be carried from points situated higher up than Bartholin's glands, and the external denudation may be carried farther out toward the unmodified skin, and lower toward the anus. There is always later a certain amount of stretching of the perineum, and due allowance should be made for this in performing the operation.

The following are the abdominal operations for the relief of prolapse recommended by the writer:—Mayo's internal Alexander's operation; simple ventral fixation; ventral fixation of the anterior wall of the uterus; ventral fixation by means of the utero-sacral ligaments; vaginapexy; and abdominal colporrhaphy.

Mayo's Internal Alexander's Operation.—Mayo's internal Alexander's operation should be used in cases of slight prolapse where there is only moderate loss of support of the vaginal attachment, and where future pregnancies are expected. This operation is performed as follows:—A median incision is made, and the round ligament of the right side is grasped by a pair of curved clamps at the junction of the middle and outer thirds. The assistant, holding this clamp, draws the ligament toward the median line and pulls the peritoneum, at the point where the round ligament enters the abdominal wall, into the form of a funnel. A pair of curved clamps with narrow blades (closed) is then inserted between the fascia and the rectus muscle of the right side and is pushed directly to the internal ring and down into the funnel of peritoneum which has been formed by the traction exerted upon the round ligament. Still located underneath the peritoneum the clamp forceps is next pushed along the course of the round ligament and made to grasp the ligament at the point where the other clamp holds it. The ligament is then drawn up through the internal ring and out to the median line under the fascia, the clamp at no time entering the peritoneal cavity. The procedure which has just been described is then carried out on the left side, and after the peritoneal wound is closed in the median line the two ligaments are drawn together over the rectus muscles and united by several interrupted sutures.

Ventral Fixation.—Many methods of fixing the uterus to the anterior abdominal wall have been devised. The following technique is the one usually adopted by the writer:—

The patient is placed in the Trendelenburg position and the abdomen is opened by a median incision. The fundus of the uterus is grasped in a pair of bullet forceps in the median line and the uterus is drawn well up to the median incision. A strong braided silk suture in a full curved needle is passed well into the uterine tissue just below the attachment of the right Fallopian tube. The suture is then passed directly up through the abdominal wall at a point where its entrance into the uterine wall would be most naturally in relation with the abdominal peritoneum. The suture is continued through the fascia about half an inch from its cut edge, and is then returned again through the fascia and muscle into the abdominal cavity at a point at about half an inch from where it first entered the abdominal wall. The ends of the silk sutures are secured with hæmostat forceps and the same procedure is repeated by another suture on the left side of the uterus. When both sutures have been accurately placed they are drawn taut and tied so that the knot is within the abdominal cavity. This method is much better than that of tying the knot in such a way that it can communicate with the abdominal wound, because, if by chance the abdominal wound should become septic, the silk knot is liable to become the basis for a troublesome sinus. The wound should be closed in layers.

This operation for ventral fixation may be performed at any part of the posterior wall of the uterus, according to the amount of slack vagina which it is necessary to reduce.

Ventral Fixation of the Anterior Wall of the Uterus.—The sutures are placed as in posterior fixation, at any level of the anterior wall from the base of the round ligaments to the internal os. This method is effective and lessens the possible danger of dystocia.

Ventral Fixation by Means of the Utero-sacral Ligaments.—This operation can be used in cases of extensive procidentia. The technique is exactly the same as that described under Ventral Fixation, excepting that the sutures are passed through the uterus at the level of the juncture of the utero-sacral ligaments. The right and left sutures should be passed in such a manner as to include the right and left utero-sacral ligaments. They are then passed through the abdominal wall, including the fascia, and returned to the abdominal cavity, thus rendering it necessary that the knots shall be tied inside the cavity. It is usually best to anchor the fundus of the uterus to the abdominal wall with one catgut suture. (See Fig. 446.) This, I believe, is the most effective method for curing severe cases of prolapse, and is especially useful in treating hard-working women. It should not be used if there is likelihood of future pregnancy, unless the the tubes are tied off during the operation, and unless the consent of the patient and her husband has first been obtained.

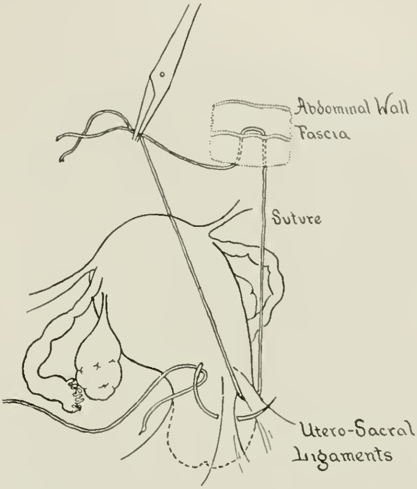

Fig. 446.—Ventral Fixation by the Utero-sacral Ligaments. The suture on the right has been passed through the right utero-sacral ligament and through the abdominal wall including the fascia. The two ends of the suture are seen secured in a pair of hæmostats ready for tying when the suture on the left has been similarly placed. When the sutures are tied, the utero-sacral ligaments will be drawn snugly up to the abdominal wall and the knots will be inside the peritoneal cavity. This operation is not to be employed in women who are likely to bear children.

Vaginapexy.—This operation, devised by Dr. W. H. Baker, is one that is especially adapted to cases of very marked cystocele with procidentia. It should be used only where the uterus is light and uncongested, and most commonly where there has been atrophy of the fundus with elongation of the cervix, so that, after high amputation of the cervix, the body of the uterus is little more than a firm cap to the vault of the vagina. When the operation is performed an experienced assistant should have his finger in the vagina to give information concerning the amount of reduction of prolapsed portions. The vault of the vagina is seized from the abdominal side by two bullet forceps which catch the tissues in Douglas's fossa at two points about three-quarters of an inch posterior to the uterine vessels. The forceps are passed into the tissue deeply enough to grasp the strong connective tissue below the vaginal mucous membrane, but great care should of course be taken that the forceps do not pierce the vaginal cavity. The assistant who has his finger in the vagina instructs the operator as to when the vagina is sufficiently drawn up. When the bullet forceps have been correctly placed the tissue which they are grasping is brought directly up to the abdominal wall, the uterus being tipped forward. Braided silk sutures are then passed through the portion of tissue which is held by the bullet forceps, and these sutures are placed in the abdominal wall (including the fascia) in the manner described in the section which treats of ventral fixation, and the knots are tied inside the abdominal cavity. The uterus is at first completely anteverted. It will be found that the portion of the bladder which had formerly protruded into a cystocele is drawn completely into the pelvis and into its normal position. The wound is carefully closed by layers.

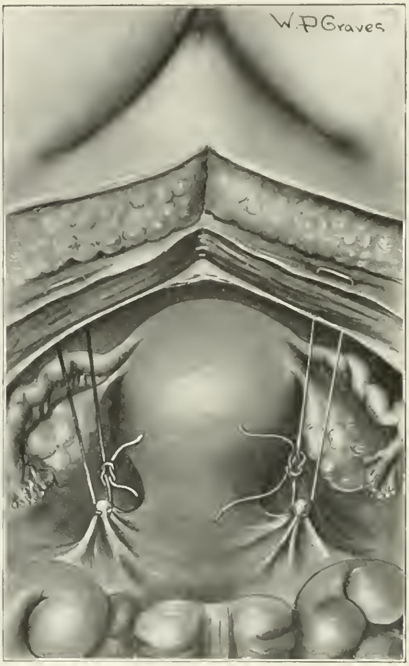

Fig. 447.—Baker's Method of Vaginapexy. The drawing shows the sutures placed in position for vaginapexy. For the purposes of illustration the sutures are represented *as not drawn tight*. When the sutures are drawn tight, the two folds of the posterior cul-de-sac are approximated to the peritoneum of the anterior abdominal wall, while the fundus of the uterus is tipped directly over and forward toward the bladder. The drawing represents semi-diagrammatically a view directly into the wound, the patient being in the Trendelenburg position.

These last two operations, if properly done, cause no special pain and no bladder symptoms. In connection with later effective plastic operations the most severe cases of procidentia may be successfully cured. (See Fig. 447.)

The Writer's Method of Abdominal Colporrhaphy.—This operation is performed in cases where, on account of enlargement and weight of the uterine body, it is important to extirpate the organ. The steps of the operation are as follows:—

With the patient in the perineal position a circular incision is made around the cervix below the level of the prolapsed bladder. The dissection is then carried up the cervical wall, as in a vaginal hysterectomy, nearly to the peritoneal cavity and as far as the point where the blood-vessels enter the uterus. A pair of double hooks is then attached to the cervix and the patient is placed in the Trendelenburg position and prepared for the abdominal operation. Through a median incision a complete hysterectomy is then performed in the usual manner. (See the article on Surgery of the Uterus, in a later volume.)

When the uterus has been completely freed from its vaginal attachments, an assistant draws it out through the vaginal outlet by means of the double hooks clamped to the cervix. The wound which extends from the vagina into the abdominal cavity is then closed as in any complete hysterectomy, and the whole wound is carefully covered with peritoneum. A braided silk suture is passed through each end of the vaginal wound in such a manner that it shall secure a firm hold in the perivaginal connective tissue. The ends of these sutures are left free in the abdominal cavity, the peritoneum being closed around them. When the operation for hysterectomy has been finished the two silk sutures are drawn firmly up to the abdominal wound, one end of each being passed through the abdominal wall (including the fascia) and back into the abdominal cavity and tied to the other end, the knots being thus left inside the abdominal cavity.

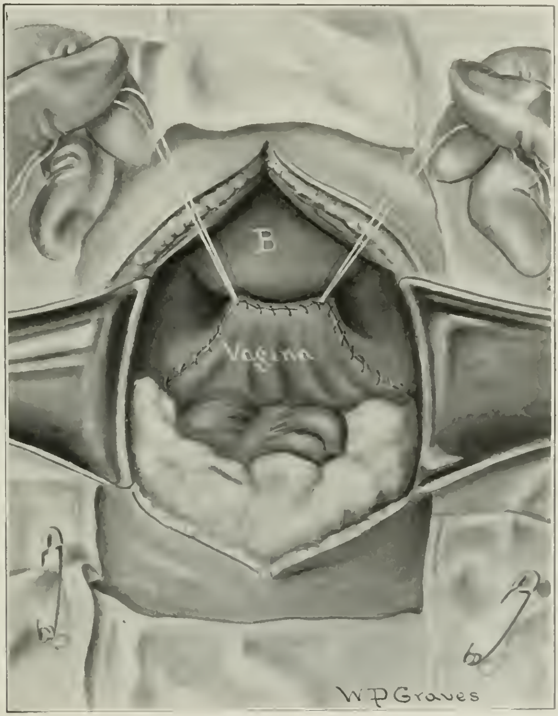

Fig. 448.—The Writer's Method of Performing Polk's Abdominal Colporrhaphy. Complete combined hysterectomy has been performed. The peritoneal cavity has been completely closed and in it have been left two braided silk sutures, sewed firmly into the upper angles of the vagina. These sutures are passed through the abdominal wall (including the fascia) and tied inside the abdomen. When the sutures are tied the vagina is in contact with the anterior abdominal wall.

Additional silk sutures may be placed if there is any doubt as to the strength of the first two. The abdominal wound is closed in layers. (See Fig. 448.)

Operations for the Cure of Vesico-Vaginal Fistula.—The repair of vaginal fistulæ in these days of improved obstetrical practice is far less commonly necessary than formerly. The large gaping fistulæ, which were once so common and which resulted from the impaction of the fœtal head against the pubic bones, and occasionally from the improper use of forceps, are now rarely to be seen. The fistulæ, as they occur at present, are more apt to be small sinuses, and are probably most frequently caused by the accidents of severe pelvic surgery. The methods for repairing vaginal fistulæ may be divided into two classes: first, the method devised by Sims—namely, denudation and closure by one row of stitches; and, second, the method of separating the vagina from the bladder or rectum, and closing the two rents separately.

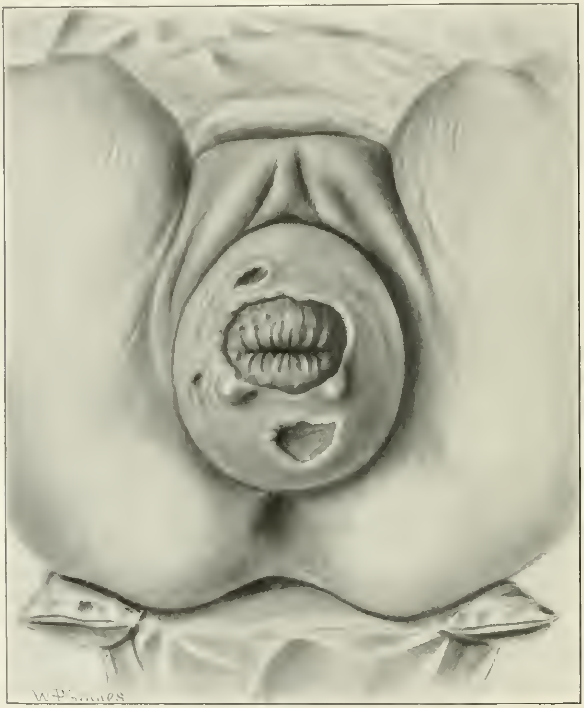

FIG. 449.—A Case of Complete Procidentia of Twenty-five Years' Duration, with severe ulceration, cured by hysterectomy, abdominal colporrhaphy, anterior colporrhaphy, and perineorrhaphy.

It may be said, in general, that the first method is applicable to small fistulæ where there is little tension, and that the second method is applicable to small fistulæ and is preferable in large fistulæ where there is considerable tension.

Sims's Method.—The edges of the fistula are denuded in an oval figure the axis of which corresponds with the axis of the fistulous rent. The denudation of the vaginal mucous membrane is made with Emmet's scissors, and is extended a centimetre or more beyond the edge of the fistulous opening. In depth this denudation is carried down to the mucous membrane of the bladder, all the membrane which lined the fistulous tract being thoroughly removed. A single row of wire sutures is then introduced, each suture being carried out well beyond the vaginal edge of the wound and extending to such a depth that the needle just misses the mucous membrane of the bladder. The wire sutures are then twisted and cut, to be removed in about twelve days. (Fig. 450.)

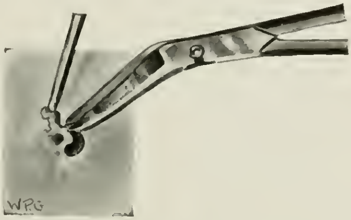

FIG. 450.—Method of Denudation in Operation for Vesico-vaginal Fistula.

Method of Separating the Vagina from the Bladder.—Many modifications and variations of this method have been described, and for a special study of complicated cases the reader is referred to the last edition of Kelly's "Operative Gynæcology." The essential principles of the method are as follows:—

An incision, usually a longitudinal one, is made through the vaginal mucous membrane. The mucous membranes of the bladder and vagina are then separated the one from the other, for a distance of half a centimetre or more from the fistula on all sides. The edges of the opening in the bladder are then brought into coaptation by a continuous mattress suture of chromicized catgut, care being taken not to penetrate the mucous membrane of the bladder. If this suture is carried well out from the edges of the wound, these edges, when the suture is tightened, will be turned into the bladder, and in this way the wound will be enabled to sustain a greater hydraulic pressure, as under such pressure the edges show a tendency to press against each other. The vaginal membrane is next approximated by interrupted mattress sutures, the aim being to secure as perfect coaptation as possible.

After-Treatment.—The vaginal wound may be treated by the usual method of daily irrigations of boric-acid solution. In order to prevent the pressure which is exerted on the walls of the bladder by the accumulating urine, it is sometimes customary to keep the patient's bladder empty by the use of a self-retaining rubber catheter, or by a male rubber catheter kept in place by means of adhesive straps. A much better method is to catheterize at frequent intervals or to have the patient, if able, void her urine frequently. Not more than four ounces of urine should be allowed to collect in the bladder. For the first five or six days the patient should be waked at night at regular intervals.

SURGICAL DISEASES AND WOUNDS OF THE MALE GENITAL ORGANS.

By FRANKLIN G. BALCH, M.D., Boston, Mass.

I. ANATOMY.

THE male external genital organs consist of: I. The penis, through which passes the lower portion of the urethra; II. The scrotum; III. The contents of the scrotum—testes, epididymides, spermatic cords.

1. The Penis.—The penis is an approximately cylindrical organ, dependent from the anterior aspect of the pubic symphysis, and subserving the functions of copulation and micturition, essentially the former. It consists of a proximal extremity, a body, and a distal extremity.

The proximal extremity is buried in the depths of the perineum, where it is made fast to the anterior pubic wall by the suspensory ligament and the crura. The suspensory ligament is a sort of sling composed of elastic fibres, which are attached above to the anterior surface of the pubic bone and pass into the linea alba. These fibres also surround the corpora cavernosa and the corpus spongiosum, and are continued downward to become fused with the perineal rhaphe. The attachments of the corpora cavernosa to the ischio-pubic rami on each side are termed the crura.

The body of the penis (Fig. 451), in the flaccid state, is nearly cylindrical, with an antero-superior and two postero-lateral surfaces. During erection these surfaces are emphasized, so that the shape becomes more like a triangular prism with rounded edges. It consists of the erectile organs—the corpora cavernosa, the corpus spongiosum, the glans, and a system of sheaths.

The corpora cavernosa are two parallel, fibro-vascular bodies, cylindrical in shape, varying in length from 15 to 21 cm. according to their degree of erection, and occupying the antero-superior portion of the penis. They are attached to the pubic rami by their proximal extremities, called the crura. They lie in close contact, separated only by a single septum, which is pierced by many openings to allow free communication between their respective blood-spaces. They consist each of a sheath, or tunica albuginea, enclosing erectile tissue. From the inner surface of the tunica albuginea branch out numerous fibrous prolongations, or trabeculæ, some wide and thick, others narrow and thin. All these fibres, whatever their points of origin, converge toward one another and meet at various angles, dividing the cavity enclosed within the sheath into a great number of compartments, or blood spaces. The trabeculæ, like the sheath from which they arise, are composed of connective tissue and elastic fibres, and their smaller bundles occasionally possess well-developed muscle-fibres. The blood-spaces show marked irregularity in shape and dimensions, being broadest immediately beneath the sheath, and largest in the axial portion of the body. They intercommunicate freely and are lined with a continuous layer of endothelial cells. For this reason they are regarded by certain authors as venous cavities, much dilated and connected by numerous anastomoses.

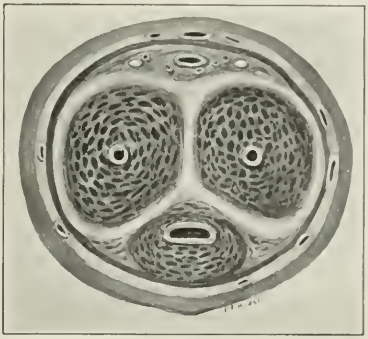

FIG. 451.—Anatomical Cross Section of the Penis, showing the following parts: —skin, superficial dorsal vessels, sheath, deep vessels and nerves, tunica albuginea, corpora cavernosa with vessels, and the corpus spongiosum urethræ.

The corpus spongiosum is a single, cylindrical body, 12 to 16 cm. in length, similar in structure to the corpora cavernosa, but with a thinner sheath and smaller blood-spaces. It is placed in the median line at the junction of the two postero-lateral surfaces of the penis, and presents for consideration the bulb, the middle portion, and the glans.

The bulb is a proximal, pear-shaped enlargement with a base pointing backward and downward.

The middle portion occupies the gutter beneath and between the corpora cavernosa. It is cylindrical, varying from 10 to 18 mm. in diameter, according to its state of flaccidity or erection, and is traversed from behind forward by a canal, the urethra, which follows closely the axial line, but lies nearer the superior than the inferior surface.

The glans is a distal, conoidal enlargement, with an apex directed forward and cleft by a vertical slit, 6 to 8 mm. long, called the external urinary meatus, which is the distal termination of the urethra. This enlargement takes place chiefly above the urethra, so that the glans forms a sort of butt against whose base come the corpora cavernosa like two catamarans. This base is oblique from above downward, being bevelled off at the expense of the inferior surface.

A system of sheaths encloses the erectile parts of the penis. It comprises skin, dartos, a cellular layer, and an elastic layer. The skin is continuous with that of the adjacent parts, and forms on the inferior surface of the penis a median rhaphe. The dartos is a layer of smooth muscle fibres, mostly longitudinal, some oblique or transverse, and crossing the others at many angles. In the distal third of the penis the dartos, by its interlacing, has a plexiform character. Under the influence of cold its fibres contract and, by pressure on the erectile organs, reduce the calibre of the penis. During the sexual orgasm they compress the superficial veins, and, by favoring venous stasis, assist in erection. The cellular layer is composed of loose tissue, very rich in elastic fibres; and the elastic layer, also called the "fascia penis," closely invests the erectile organs, whose proper sheath it forms. Over it the dartos and skin glide during their excursions. Along the median rhaphe of the penis the elastic layer is united at once to the skin and to the corpus spongiosum. Proximally, it is continuous with the suspensory ligament and with the superficial perineal fascia. Distally, it is attached to the base of the glans. The distal extremity of the penis is formed by the glans, already described, and its envelope, the prepuce.

The glans has a diameter at the base greater than that of the body of the penis, and thus forms a circular projecting rim or shoulder, called the corona glandis. This projection, which is more prominent on the antero-superior than on the postero-lateral surfaces, is bounded proximally by a circular furrow, called the balano-preputial groove. The portion of the penis occupied by this groove is distinctly narrowed, and is, therefore, known as the neck. The surface of the glans is smooth: on its inferior aspect is a median longitudinal groove, beginning behind the external urinary meatus and extending back to the balano-preputial groove, into which is inserted the frenum, or distal extremity of the median rhaphe of the penis. On either side of the frenum is a small fossa. The erectile tissue of the glans lies above and beside the urethra, being absent below it. The blood-spaces are larger than those in the bulb and middle portion of the corpus spongiosum.

The prepuce, or *foreskin,* is a loose cuff which envelopes the glans: it is formed by a reduplication of the sheaths investing the body of the penis. The innermost, or elastic, layer does not enter into its composition. The others, on reaching the balano-preputial groove, double on themselves to form a dependent fold, whose layers, in a cross section from without inward, are skin, dartos, cellular layer, cellular layer, dartos, skin. The innermost layer of skin is thus brought into contact with the surface of the glans, and these two apposed surfaces assume the characteristics of mucous membrane, being without sweat-glands or hairs, but possessing a large number of highly sensitive papillæ. There are also numerous rudimentary sebaceous glands, known as Tyson's glands, located in the depths of the preputial cavity, in the balano-preputial groove, upon the corona glandis, and in the fossæ on either side of the frenum. The prepuce varies greatly in length in different persons. In infancy it extends beyond the glans, to which it forms a sort of vestibule; and occasionally this condition persists in adult life. Usually, however, it retracts after puberty so as to cover not more than two-thirds of the glans; and it may shrink to a narrow collar, leaving the entire glans permanently exposed. Normally the orifice of the prepuce is large enough to allow its retraction over the corona, thus providing for the elongation of the penis during erection and permitting the exposure of the glans at coitus. At times, however, the insufficient diameter of the preputial orifice results in the permanent imprisonment of the glans in the preputial cavity, a condition to which is given the name of phimosis. Retraction of the foreskin may also be hindered by shortness of the frenum, whose length is very variable. Usually it is inserted 8 to 10 mm. behind the meatus, but sometimes it reaches to the edge of the meatus, thereby interfering with the movements of the prepuce and rendering erection painful.

The penis, as thus described, is supplied with blood-vessels, lymphatics, and nerves.

Arteries of the Penis.—The arteries of the penis are divided into two groups: (1) the arteries which supply the various layers of the sheaths of the penis; (2) the arteries which supply the erectile parts.

(1) The arteries of the sheaths of the penis are: the superficial external pudic branch of the femoral; the superficial perineal and the dorsal artery of the penis, branches of the internal pudic. The dorsal artery of the penis arises from the internal pudic. It passes upward between the crus and the pubic symphysis, and, after piercing the suspensory ligament, passes forward over the dorsum of the penis to the glans; here it divides into two branches which supply the foreskin and the glans. The artery is placed parallel to the dorsal vein and the corresponding artery of the opposite side. It supplies the skin and the fibrous sheaths of the corpora cavernosa, sending branches inward to anastomose with the artery of the corpus cavernosum.

(2) The arteries which supply the erectile parts all arise from the internal pudic. Those which go to the corpus spongiosum have a threefold distribution. Branches of the transverse perineal supply the bulb. The middle portion of the corpus spongiosum is also supplied by the transverse perineal, and by the dorsal artery of the penis. The third, terminal, or glandular portion of the corpus spongiosum is supplied by branches of the dorsal artery of the penis.

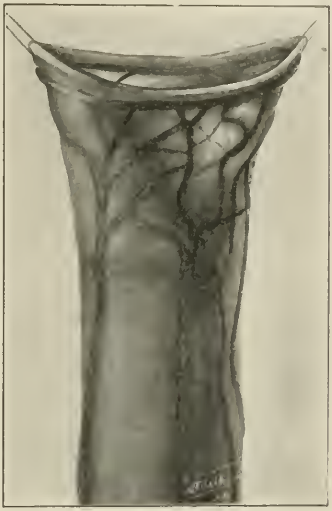

FIG. 452.—Circulation of the Foreskin. (Drawn from life.) The blood-vessels of the prepuce are shown passing around from above downward and forward.

The corpora cavernosa are supplied by two arteries of the same name, terminal branches of the internal pudic. They arise between the crus penis and the ramus of the os pubis, and give off recurrent branches to the crura. The artery enters the corpora cavernosa near the upper border of the median septum, where the two homologous arteries are close together. They gradually separate, one from the other, to gain the centre of the body, after which they maintain their axial relation to the end. The two arteries are closely connected by anastomoses. Finally, at the anterior extremity of the corpora cavernosa, the two arteries unite to form one arch. The corpora cavernosa also receive a few small branches from the dorsal artery of the penis.

Veins of the Penis.—The veins of the penis (Fig. 452) are arranged in two plexuses, a superficial, and a deep.

The superficial veins take their origin from the sheaths of the penis, travelling in the subcutaneous tissue, and ending in the superficial dorsal vein, which, in its turn, empties into the internal saphenous of either the right or the left side.

The deep veins come from the erectile organs, and, passing between these organs and the fascia penis, empty, for the most part, into the deep dorsal vein, one of the principal affluents of the plexus of Santorini (prostatic). Those which do not go into the dorsal vein enter directly into the prostatic plexus or the internal saphenous vein. Although separated, one from the other, by the fascia penis, the two venous systems communicate freely with each other behind the glans. Valves are present in both systems of veins.

Lymphatics of the Penis.—The lymphatics of the penis are divided, like the veins, into a superficial and a deep system.

The superficial lymphatics come from the skin. They form two principal plexuses, one upon the prepuce, the other on the median rhaphe. From the preputial plexus escape a certain number of small trunks, which unite into a common superficial dorsal trunk, which follows the course of the superficial dorsal vein. At the root of the penis it bifurcates to empty into the lymph nodes of the groin. The lymphatic plexus in the median rhaphe gives off eight or ten branches which cross the sides of the penis to gain its posterior surface, where some enter the superficial dorsal lymph trunks, while others preserve their independence and enter separately into the highest inguinal lymph nodes. The dorsal trunk is often double, in which case the canals may cross and empty into the nodes of the opposite side.

The deep lymphatics take their origin upon the glans, where they form a double plexus—a superficial, situated in the mucosa, and a deep plexus beneath it. These plexuses communicate freely about the meatus with the lymph vessels from the urethra. Behind the corona glandis they are also connected with the lymphatics of the mucous layer of the prepuce, which communicates, in its turn, with the lymphatics of the skin. The submucous lymphatics anastomose with those of the fossæ around the frenum. The efferent trunks of these plexuses travel upward and backward, following the balano-preputial groove, thus forming a sort of collar around the corona. Upon the dorsum the deep lymphatics unite into a single common stream which accompanies the deep vein backward, where it bifurcates to empty into the big lymph nodes. The deep dorsal stream may not bifurcate, but may empty into the inguinal lymph nodes on either side. The deep trunks, like the superficial, may also be double, and the channels, crossing, may empty into the nodes of the opposite side.

Nerves of the Penis.—The coverings of the penis, including the double layer of mucous membrane which covers the balano-preputial cavity, receive their nerves from a branch of the genito-crural (lumbar plexus), also from branches of the internal pudic nerve (sacral plexus). These nerves are distributed both to the skin and to the dartos. The erectile organs are rich in nerves which are both sensory and motor. They arise from two sources: (1) the lymphatic plexus of the sympathetic system, and (2) the superficial perineal nerves, two branches of the internal pudic, connected with the cerebro-spinal system.

2. The Scrotum.—The scrotum is a closed pouch or bag dependent from the perineum posteriorly to the penis, and serving to contain and protect the testes, epididymides, and part of the spermatic cords. It varies in size in different individuals, and according to its state of contraction or relaxation. It is composed of two layers of tissue—the skin and the dartos. The skin is continuous with that of the adjacent parts, and is provided with sparse hairs and numerous sebaceous and sweat glands. In the median line it forms a rhaphe, continuous anteriorly with the rhaphe of the penis and posteriorly with that of the perineum. The dartos is continuous with the dartos of the penis and the two are identical in structure, but that of the scrotum is more highly developed. Normally its muscle fibres are in a state of tonic contraction, causing the scrotum to act as an efficient support to its contained organs and throwing the skin into characteristic rugæ or folds. Under the influence of cold this contraction increases, and during sexual excitement it promotes congestion of the parts. Under the influence of warmth or debility, the dartos relaxes, allowing the testes to descend and hang lower down between the thighs. When this condition—popularly known as "swing-bag"—is persistent or extreme, it may give rise to pain from the weight and dragging of the unsupported organs. In the median line, corresponding with the cutaneous rhaphe, the dartos sends in a thin septum which divides the scrotal cavity into two lateral compartments.

The vascular, lymphatic, and nerve supplies of the scrotum are as follows:

Arteries of the Scrotum.—These are all bilateral and they anastomose terminally. They are: the superficial pudic branch of the femoral; the deep external pudic branch of the femoral; the superficial perineal branch of the internal pudic.

Veins of the Scrotum.—These veins, which correspond to the above-named arteries, are the following: the superficial external pudic, emptying into the internal saphenous vein at the saphenous opening; the deep external pudic, emptying into the femoral; the superficial perineal, emptying into the internal pudic.

Lymphatics of the Scrotum.—The lymphatics of the scrotum pass obliquely upward and outward into the groins, and terminate on each side in the group of superficial lymph nodes which are placed just above Poupart's ligament.

Nerves of the Scrotum.—These nerves, which occupy symmetrical positions on both sides of the scrotum and intercommunicate at different points, are the following: The ilio-inguinal, from the first lumbar nerve through the lumbar plexus; the superficial perineal nerves, cutaneous branches from the internal pudic nerve of the sacral plexus; the inferior pudendal, a cutaneous branch from the small sciatic nerve of the sacral plexus.

Contained within the scrotum are the remaining male external genital organs, next to be described.

3. The Testes.—The testes are two ovoid glandular organs, situated one in each of the scrotal compartments, whose function is to secrete the spermatozoa. Their size varies in different individuals, the length of the greatest axis averaging about 4 or 5 cm. The left testis is usually slightly larger than the right. Each consists of the tunica albuginea, the tunica vasculosa, the parenchyma, the spermatozoa, and the hydatids of Morgagni.

Tunica Albuginea.—The tunica albuginea is a tough, membranous capsule composed of dense fibrous connective tissue. In the upper, posterior portion of the testis, this capsule is thickened into a ridge, called the mediastinum testis or corpus Highmori, which projects inward and from which radiate numerous trabeculæ and septa, dividing the gland substance into pyramidal lobules.

Tunica Vasculosa.—Lining the tunica albuginea, and reflected over the septa just described, is the tunica vasculosa, which carries the capillary blood supply to the lobules.

Parenchyma.—The parenchyma or glandular secreting tissue, contained within this vascular tunic, is composed of a series of seminiferous tubules, which are divided into convoluted tubules, straight tubules, and the rete testis.

The Convoluted Tubules.—The convoluted tubules are round, vermiform tubes, each about 140 microns in diameter, proceeding inward with many turns in a serpentine plexus from the periphery of the gland toward the mediastinum testis, and on the way progressively uniting with one another at acute angles. It is the disentangling of these tubules which produces the characteristic "threading out" of the testis, seen at autopsy. The wall of each tubule is composed of connective tissue overlaid by a thin elastic membrane, and is lined with stratified secreting epithelium of three layers. The first layer consists of two kinds of cells, viz., the cells of Sertoli, which are not concerned in spermatogenesis; and the spermatogonia, which produce spermatozoa by the following cycle:—Each spermatogonium divides by mitosis into spermatocytes, which form the second layer. The spermatocytes of this layer in turn divide twice, each producing four spermatids, which form the third layer. Finally, in this third layer the spermatids develop into spermatozoa and are cast off into the lumen of the tubule.

The Straight Tubules.—As the convoluted tubules, in diminishing numbers, approach the mediastinum testis, they become straight and are reduced in calibre to 20 or 25 microns. These straight tubules consist of a basement membrane lined with a single layer of low columnar epithelium. They enter the mediastinum testis and in its substance form the rete testis.

Rete Testis.—The rete testis is a network of excretory ducts, some small, some as large as 180 microns in diameter, lined with a single layer of cuboidal or flat epithelial cells.

The Spermatozoa.—The spermatozoa, the final product of the secretory activity of the gland, are highly motile, pin-shaped, pollywog-like bodies, averaging about 70 microns in length. Each consists of a head and a tail. The head is developed from the nucleus of the antecedent spermatid. It is pyriform in shape, with apex directed forward, and about 5 microns long and 2 or 3 microns broad. The tail is developed from the protoplasm of the antecedent spermatid, and contains as its core a slender filament, the axial fibre, derived from the centrosome of the antecedent spermatid. The tail is 1 micron or less in diameter and about 65 microns long, and is divided into three pieces —the middle piece, the main piece, and the end piece. The middle piece, the section next the head, is about 5 microns long. The main piece is 50 microns long and grows progressively slender. The end piece, or terminal projection of the axial fibre, is 10 microns long. To the ciliary movement of the tail is due the motility of the spermatozoon, which is thus enabled, when deposited in the female generative tract by the act of coitus, to penetrate and unite with the ovum and thus consummate the function of impregnation.

Hydatids of Morgagni.—Connected with the upper pole of the testis by short pedicles may be one or more hydatids of Morgagni—solid lobular bodies composed of highly vascular connective tissue and covered with ciliated columnar epithelium. In the pedicle is a duct lined with similar cells. These hydatids are generally believed to be remains of the anterior portion of the embryonic Muellerian duct.

Blood Supply of the Testis.—The testis receives its blood supply through the spermatic artery, a branch of the aorta. The venous return is through the pampiniform plexus, a series of veins which pass out and up from the posterior portion of the testis and later unite into the spermatic vein, which on the right side empties into the inferior vena cava, on the left into the left renal vein.

Lymphatics and Nerves of the Testis.—The lymphatics arise from a plexus in the tunica vasculosa and terminate in the lumbar lymph nodes. The nerves, from the renal, aortic, and hypogastric plexuses of the sympathetic system, form the spermatic plexus, by which the testis is supplied, although the exact manner of its terminal innervation is not definitely determined.

4. The Epididymides.—The epididymis is an elongated body lying along the upper and posterior portion of each testis and forming part of its excretory mechanism. Each epididymis is made up as follows:—From the rete testis, through the tunica albuginea, finally emerge about fifteen ducts, called ductuli efferentes or vasa efferentia, whose walls are formed of fibrous tissue and smooth muscle fibres, and which are lined in some places with a single layer of ciliated columnar cells, in others with a stratified epithelium of non-ciliated cuboidal cells. These ducts go through a further series of convolutions, which constitute the globus major.

The Globus Major.—The globus major, or head of the epididymis, is an oblong enlargement of the epididymis situated just behind the upper pole of the testis. Near its lower portion the ductuli efferentes unite into a single tube, the ductus epididymidis, whose wall consists of a layer of circularly disposed smooth muscle fibres overlaid by a basement membrane, and which is lined with a stratified, ciliated epithelium. This duct, which is about 20 feet in length, now passes through a complicated series of convolutions, forming the body of the epididymis and the globus minor.

The Body of the Epididymis.—This is an enlongated cylindrical structure, extending along the entire posterior border of the testis and the globus minor.

The Globus Minor.—The globus minor, or tail of the epididymis, is a second and smaller enlargement of the epididymis, situated below and posterior to the lower pole of the testis.

The Ductulus Aberrans.—The ductulus aberrans, or vas aberrans of Haller, is given off from the ductus epididymidis near its termination in the globus minor. It is a diverticulum or blind tubule with walls of vascular connective tissue lined with ciliated columnar or cuboid epithelium.

The Paradidymis.—The paradidymis, or organ of Giraldès, is connected with the vas aberrans, and the two are identical in structure. Both the paradidymis and the vas aberrans are functionless remains of the fœtal mesonephron, or main portion of the Wolffian body.

The Appendix Epididymidis.—The appendix epididymidis is also occasionally connected with the epididymis. It is a vesicle lined with cuboid epithelium and contains a clear fluid like that found in the hydatids of Morgagni. It is probably a remnant of the Muellerian duct.

The epididymis and its appendages have the same vascular, lymphatic, and nerve supply as the testis.

5. The Spermatic Cords.—These are two funicular structures, each about 1.5 cm. in diameter, by which the testes and epididymides are suspended in the scrotum. The left cord is somewhat longer than the right, so that the left testis hangs the lower. Each cord is an aggregate of several components, namely, the vas deferens, the spermatic artery, the artery of the vas deferens, the pampiniform plexus of veins, the lymphatics, and the spermatic plexus of nerves.

The Vas Deferens.—The vas deferens, the terminal excretory duct of the testis, is continuous with the ductus epididymidis at the lower portion of the globus minor. It is about two feet long and 2 mm. in diameter, and consists, from without inward, of the following layers: a fibro-elastic adventitia; a longitudinal layer of smooth muscle; a circular layer of smooth muscle; a submucosa containing smooth muscle; a tunica propria of connective tissue; and a mucosa of two layers of columnar epithelium. It will be seen that the walls are relatively very thick and the lumen of the duct very small.

The Spermatic Artery.—The spermatic artery is given off from the aorta.

The Artery of the Vas Deferens.—This artery, which is a branch of the superior vesical, lies close upon the vas deferens and supplies it.

The Pampiniform Plexus of Veins.—The individual vessels which enter into the composition of this plexus eventually unite to form the spermatic vein.

The lymphatics are the same as those of the testis.

The Nerves.—The nerve supply is furnished by the spermatic plexus of nerves.

All the elements enumerated above are bound together by areolar tissue into a single structure—the spermatic cord. Leaving the scrotum at the external inguinal ring, the cord passes through the inguinal canal to the internal inguinal ring, where its components diverge subperitoneally. The veins and lymphatics go to their respective destinations, the arteries and nerves to their trunks of origin. The vas deferens hooks around the outer side of the deep epigastric vessels near their point of origin, crosses the internal iliac vessels, and dips down into the pelvis to the base of the bladder, crossing the obliterated hypogastric artery, but passing between the ureter and the posterior bladder wall. Here it becomes first sacculated, then narrowed, and finally unites with the duct of the seminal vesicle on the corresponding side.

In early fœtal life, the testes and epididymides, which are developed respectively from the embryonic genital folds and Wolffian bodies, lie below the kidneys in the retroperitoneal space. Attached to the lower pole of each testis is a fibrous cord, containing also some muscle tissue, which passes down through the inguinal canal to be inserted into the base of the scrotum. This cord, which is called the gubernaculum testis, receives accessory fibres from Scarpa's triangle, from the perineum, and from the root of the penis. Toward the end of fœtal life, testis and epididymis begin to descend through the inguinal canal, whether merely guided by the gubernaculum or aided by its actual contraction is not definitely known. As they pass through the canal, the spermatic cord is for the first time formed behind them; and testis, epididymis, and cord in their progress become invested with a series of coverings derived from the tissue layers through or past which they go. The process of descent is normally complete at or shortly after birth. The above-mentioned system of coverings will now be described as found in the adult, with reference to their fœtal sources of origin.

6. The Coverings of the Testis, Epididymis, and Spermatic Cord.—*The Tunica Vaginalis.*—The tunica vaginalis is a layer of serous tissue immediately covering the tunica albuginea. It passes from the surface of the testis over a great part of the epididymis and the lower portion of the cord, then is reflected on itself so as to form a closed sac, or potential cavity, like the pericardium, whose parietal and visceral surfaces, normally in contact, are covered by a layer of endothelial cells. It is derived from the processus vaginalis, a pouch of peritoneum which precedes the testis in its course down the inguinal canal. At first its cavity communicates with the peritoneum, but later the upper portion of the pouch becomes obliterated, leaving only a short funicular portion or neck of the tunic surrounding the cord just above the testis.

The Infundibuliform Fascia.—The infundibuliform fascia is a complete pouch of thin fibrous tissue containing testis, epididymis, and cord, and is continuous at the internal inguinal ring with the transversalis fascia from which it is derived. Over the testis it lies next and external to the tunica vaginalis.

The Cremaster Muscle.—This is a thin layer of striated muscle-fibres, derived usually from the lower border of the internal oblique, disposed in a series of dependent loops over the cord as far down as the testis, and united by a tenuous areolar tissue, thus together forming the cremasteric fascia. The cremaster exerts a reflex and sometimes a voluntary action in drawing up the testis closer to the perineum, and must probably be regarded as the remnant of a once important mechanism, capable of protecting the testis and at the same time endowing it with the power to retract.

The Intercolumnar Fascia is a thin fibrous sac which completely encloses the testis, the epididymis, and the lower portion of the cord as far as the external inguinal ring, where it is continuous with the intercolumnar fibres of the aponeurosis of the external oblique, from which it is derived. Over the testis it lies next external to the infundibuliform fascia.

The Areolar Layer is a layer of loose tissue which overlies the intercolumnar fascia and in the scrotum serves to separate it from the dartos. In its meshes may be found the atrophic remnant of the gubernaculum, which still acts to moor the testis to the bottom of the scrotum.

This system of coverings receives its blood supply through the cremasteric artery, a branch which is given off from the deep epigastric at the inner margin of the internal inguinal ring and accompanies the cord through the inguinal canal. The veins and lymphatics of the coverings are tributary to those of the testis and the epididymis. The motor nerve supply of the cremaster muscle is from the lumbar plexus through the genital branch of the genito-crural nerve, which also accompanies the cord. The ilio-inguinal nerve likewise passes through the canal, but leaves the cord at the external inguinal ring.

It remains to describe some structures not strictly of the male external genital organs, but so closely connected with them in function that their consideration belongs with this subject.

7. The Seminal Vesicles.—The seminal vesicles are two lobulated, saccular structures, each about 6 cm. in length, placed on the posterior surface of the bladder, near its base, and lying between that organ and the rectum. They serve as repositories for the seminal fluid containing the spermatozoa, to which they probably add a secretion of their own. Histologically they are identical in structure with the terminal portion of the vasa deferentia, which lie just internal to them on either side. Each vesicle has a duct which unites, near the base of the postate gland, with the corresponding vas to form the ejaculatory duct.

8. The Ejaculatory Ducts.—The ejaculatory ducts are two tubes passing on each side from their point of origin through the substance of the prostate to empty into the urethra. Each is about 2 cm. in length and is composed of a vascular adventitia, a longitudinal layer of smooth muscle fibres, a circular layer of smooth muscle fibres, a basement membrane, and a single layer of columnar epithelium.

9. Cowper's Glands.—Cowper's glands are two round, lobulated, compound tubular glands, each about 8 mm. in diameter. They are placed immediately behind the bulb of the corpus spongiosum, between the layers of the deep perineal fascia, on each side of the urethra, into which their ducts open. The mucous membrane of these ducts consists of several layers of cuboidal epithelium, but the gland tubules are lined with a single layer of columnar cells.

10. The Urethra.—The urethra is the terminal excretory duct of both the genital and the urinary system. It is a tube (Fig. 453) which varies from 20 to 23 cm. in length and extends from the neck of the bladder, with which it is continuous, to the external urinary meatus, passing on its way through the prostate gland and the corpus spongiosum. Anatomically it is divided into four portions—the prostatic, the membranous, the bulbous, and the cavernous.

The prostatic urethra is that portion of the urethra which lies within the substance of the prostate gland. It is about 3 cm. long and fusiform in shape, with a diameter varying between 6 and 10 mm. On the floor are encountered in succession:—(1) The verumontanum, or the caput gallinaginis—a longitudinal ridge composed of erectile tissue. (2) The prostatic sinuses—two shallow fossæ lying on both sides of the verumontanum. Into these fossæ open the prostatic ducts, through which the secretion of the prostate reaches the urethra. (3) The sinus pocularis, or uterus masculinus—a depression at the distal extremity of the verumontanum, into which open the ejaculatory ducts.

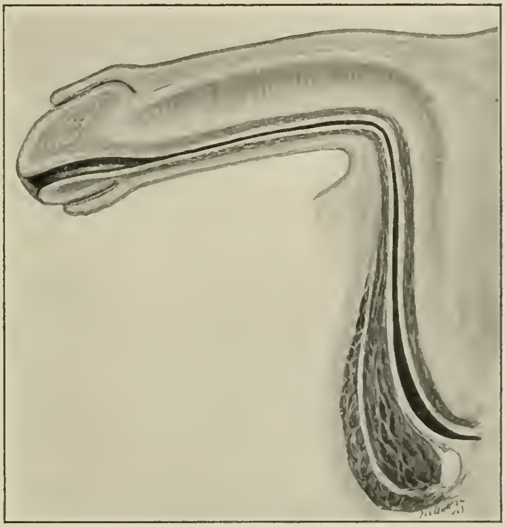

Fig. 453.—Anatomical, Sagittal Section of the Penis, showing the Relations of the Parts.

The Membranous Urethra.—The membranous urethra is that portion of the canal which extends from the prostate to the bulb of the corpus spongiosum and between the layers of the triangular ligament. It is about 2 cm. in length and 5 mm. in diameter, being curved concave anteriorly as it passes under the arch of the pubic symphysis.

The Bulbous Urethra.—The bulbous urethra is that portion of the canal which is lodged in the bulb of the corpus spongiosum. It is about 2 cm. long and is dilated to a diameter of 8 mm. Into it open the ducts of Cowper's glands.

The Cavernous Urethra.—The cavernous urethra is that portion of the canal which passes through the body and the glans of the corpus spongiosum. Its length varies with that of the penis: its diameter is about 6 mm. Within the glans it has a fusiform dilatation, called the fossa navicularis, with a maximum diameter of 10 mm.

Histologically the urethra is composed of four different layers: a circular layer of smooth muscle (absent in the cavernous portion); a longitudinal layer of smooth muscle; a tunica propria, which is rich in elastic fibres; and a mucosa, which varies in character in the different portions. For example, in the prostatic portion the canal is provided with a transitional epithelium similar to that of the bladder, and in fact continuous with it. In the membranous portion the lining epithelium is of the stratified columnar variety. In the bulbous and cavernous portions there is a single layer of columnar cells. The fossa navicularis is lined with a stratified squamous epithelium, continuous with that which covers the surface of the glans.

Embedded in the mucosa and submucosa are numerous simple and branched follicular mucous glands, known as urethral glands, or glands of Littré, the secretion from which is discharged directly into the lumen of the urethra. Not to be confounded with these are the so-called urethral lacunæ of Morgagni, blind pocketings or diverticula of the mucous membrane without the true glandular function.

The blood-supply of the seminal vesicles, ejaculatory ducts, Cowper's glands, and the upper portions of the urethra is through the inferior vesical and middle hemorrhoidal branches of the anterior trunk of the internal iliac artery. The venous return is through the vesico-prostatic and hemorrhoidal plexuses to the internal iliac veins. The lymphatics join those of the bladder and empty into the internal iliac lymph nodes. The nerves are from the hypogastric plexus of the sympathetic.

Through the urethra the urine is discharged from the bladder by the act of micturition. Through it also the seminal fluid is discharged by emission. During sexual excitement a wave-like, peristaltic contraction, begun in the muscular coat of the ductus epididymidis, is transmitted along that duct and the vas deferens, carrying with it multitudes of spermatozoa. These unite with the reserve supply poured out from the seminal vesicles into the sinus pocularis, where the whole is mixed with the prostatic secretion. At the moment of orgasm, the seminal fluid thus formed is projected through the urethra by a series of rhythmic, forcible contractions not only of the muscular coats of the urethra, but also of the perineal muscles, receiving as it goes the further secretion of Cowper's glands and of the glands of Littré. It is supposed that the erectile dilatation of the verumontanum during coitus prevents the regurgitation of semen into the bladder through the prostatic urethra.

II. EMBRYOLOGY.*

1. The genital organs of the male and the female have a close resemblance in their early developmental stages; in fact, the similarity between the adult female and the fœtal male is frequently noted.

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*The account here given has been drawn largely from McMurrich, "Manual of Embryology." (Oberdorfer.)

The penis develops from the so-called "genital eminence," a tubercle of cavernous tissue, the vessels of which are not, however, in close relationship with the "corpora." The latter grow longitudinally, while, upon their ventral surface, two clefts appear which form the genital grooves. After his studies in the young pig and in older human embryos, Reichel concludes that the so-called "genital groove" first comes behind the glans at the fourth month, at a time when the urinary tube is already completely formed in the penis itself. Both of these urethral clefts join their posterior borders from before backward, and thus form: (1) the urethra, whose epithelium is of ectodermic origin; (2) the erectile bodies; (3) the skin which surrounds them.

The glandular portion of the urethra develops in the same manner as the urethra proper, except that the genital grooves do not become smaller here; they cause in this manner the typical relationship between the glans and the corpora cavernosa. The glans is the forward end of the genital eminence; the sulcus retroglandularis resulting from a turning in of the epithelium. The skin covering the penis grows forward to enclose the glans, thus forming the prepuce, its epithelium fusing with that of the glans.

The fusion of the genital folds converts the vestibule and the groove upon the vestibular surface of the penis into the terminal portion of the male urethra. The vasa deferentia and the uterus masculinus thus open upon the floor of the urethra. The approximation of the two genital eminences interposes them between the base of the penis and the perineal body; their union forms the scrotum. The line of junction of the genital eminences is marked by the median rhaphe of the scrotum. The mesenchymal tissue primarily composing the genital swellings becomes differentiated into a series of layers which are identical with those found in the abdominal wall, as will be seen by the following schedule:—

Abdominal Wall.	Scrotum.
Integument.	Integument.
Superficial fasciæ.	Dartos.
External oblique muscle.	Intercolumnar fascia.
Internal oblique muscle.	Cremasteric fascia.
Transversalis muscle and deep fasciæ.	Infundibuliform fascia.
Peritoneum.	Tunica vaginalis.

2. Various anomalies are to be noted which are dependent upon inhibition or excess of development of parts of the sexual apparatus. When the lips of the groove on the vestibular surface of the penis fail to fuse, the penile portions of the urethra remain incomplete, the resulting defect representing the condition known as hypospadias.

Hypospadias.—Complete hypospadias and arrested development of the penis are frequently synchronous, thus giving the male a close resemblance to the female genitalia, a rare anomalous state known as hermaphroditism.

Hermaphroditism.—Since most of the cases of this condition are incomplete, and result from excessive development of the accessory sexual organs, the uterus masculinus and the clitoris, a more proper term for this class is spurious hermaphroditism. True hermaphroditism is a term which should be reserved for possible cases in which the genital ridges give rise to both ova and spermatozoa in the same individual. Such cases are of extreme rarity in the human species.

The urethra of the adult is the real representative of the cloaca, but some additional points in fœtal development must be noted. The male urethra, as far as the bulb, is the analogue of the entire female urethra; for it, too, is the cloacal remnant. The penile urethra is formed by closure of the genital fold and by central desquamation of the invading block of cells. It is, for some time during development, also blocked.

Ectopia Vesicæ.—A word may be said with regard to ectopia vesicæ. During embryonic and fœtal life the urethra in both sexes has a stage in which it is imperforate and this stage may persist as a malformation. The pathology of ectopia is simply the bursting of the bladder and the urethra through pressure from within. Neither of the two common theories—that which attributes it to rupture of the cloacal membrane or that which represents it as being due to failure of the two sides of the primitive streak to meet in the middle line—is tenable, though they do conform to the common features of the abnormalities. There is often a scrotum. This could not occur if the primitive streak of the cloacal membrane were open. There are always a perineum, often a perfect anus, and usually a normal vagina. None of these would be present if these theories were true. The arguments in favor of a burst urinary canal are as follows:—Urine is secreted by the fœtus in utero, and, when the urethra is imperforate, all stages of distended bladder have been found. Again, when there is absence of kidneys or ureters, or when there is umbilical fistula, fœtuses have been found with persistent urethral occlusion; and, in well-recorded cases of ectopia vesicæ, an actual occlusion of the cleft urethra is reported. Signs of the distention stage are seen, in cases of ectopia vesicæ, in the condition of the pelvis, which is exactly that which would be produced by an internal force driving the symphysis pubis asunder and splaying out the entire pelvis. There is no loss of middle-line development, but the two sides of the pelvis have been pushed aside from within and the recti abdominis forced aside with them. The stage with imperforation normally exists in the developmental history of all the posterior vesical orifices. In all of these orifices the imperforation stage may persist as an abnormality. It is not uncommon for this condition to affect more than one orifice in one of these cases. The persistence of the block in the urethra is the rarest condition, as a fœtal use is made of the canal; for it is recognized that the kidneys are active during fœtal life. When this block persists, various abnormalities are met with—immensely distended bladder, umbilical fistula, epispadias, and ectopia vesicæ; these results being caused by the definite internal strains produced at the definite yielding points in the urinary canal. Or, again, the kidneys may not develop, and there may be no distention, but the block remains.

III. MALFORMATIONS.

Malformations of the penis are very rare.

Total Absence of the Penis.—This malformation has been noted by Fischer. The scrotum was normal in this case, though the descent of the testes was delayed. It was supposed that the penis was amputated during intra-uterine life.

Double Penis.—Double penis (Fig. 454) has been seen a few times, and has usually been only partial. The urethræ may or may not connect. Duplication of the glans alone is the most common condition; the division may be horizontal or perpendicular. The true urethra usually opens below the cleft.

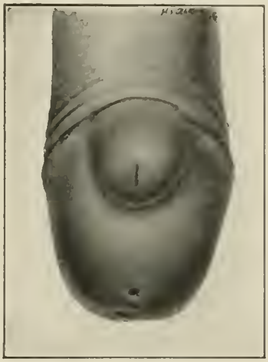

Fig. 454.—Double Penis. (After Novotny.)

Dermoid Cysts of the Prepuce and the Penis.—The origin of these abnormal conditions (Fig. 455) is related in some manner to the various openings and closures which have to do with the development of the genital system. At the same time these tumors are rare as compared with the fissural dermoids of the skull. Formerly these tumors were regarded as retention cysts, but a close study has shown them to have an entirely different origin, and to be composed of many different tissues, and thus, while some are true retention cysts, the majority must go back to some embryonic disturbance of the tissues. These cysts come, by preference, upon the foreskin, more rarely upon the body of the penis, scrotum, and perineum. All are distinguished from other secondary cysts by their microscopic structure. Their walls consist of several layers of squamous epithelium with typical rete cells and a horny layer. The subepithelial layer shows a suggestion of the papillary arrangement. The tissue as a whole resembles the structure of the skin, and thus differs from that of the retention cysts.

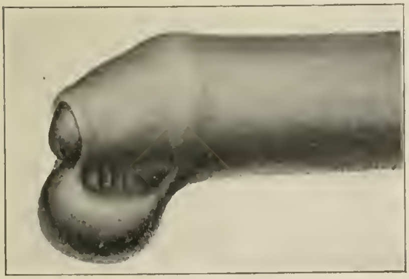

Fig. 455.—Cyst of Prepuce. (After Redard.)

Near the squamous epithelium there may also make their appearance dermoid cysts which take their origin from the *Anlage* of the mucous membrane epithelium. They also appear through incomplete closure of the borders of the genital cleft, where they come near the urethra. These cysts lie mostly in the raphe and are but slightly attached to the subcutaneous tissue. They can be easily pushed about and give more or less fluctuation when they are lined with secreting mucous membrane.

Phimosis.—Phimosis may be defined as a narrowing of the opening of the prepuce, which prevents it from being drawn back over the glans when the penis is erect. The degree of narrowing may vary all the way from cases where the prepuce can be drawn back when the penis is flaccid, to cases in which there is absolute retention of urine.

Etiology.—By far the larger number of the cases of phimosis are congenital. A certain amount of adhesion of the inner surface of the prepuce to the glans is normal and disappears as the child grows older; but when we find a decrease in the size of the opening, at the point where the mucous and cutaneous layers join, we have a true phimosis.

In addition to the congenital we may have an acquired form. This may result from trauma. Such cases sometimes follow circumcision, particularly in children. It is most often seen in cases where a redundant prepuce has been removed, but enough has been left to cover the glans, and healing has been delayed. The result is an abnormal amount of scar tissue which contracts until it is impossible to retract the prepuce. If this condition of the parts results it usually happens when the inner layer of the prepuce has not been dissected back after the clamp operation.

Any traumatism of the foreskin may give enough cicatricial contraction to cause phimosis, and the reported cases from unusual injuries are numerous. It is not likely to occur when healing is rapid, but is dependent largely on contraction of scar tissue resulting from suppuration.

In adults a common cause is found in the frequent small tears that are caused either in coitus or by attempts at forcible retraction. Anything which makes the foreskin less pliable and elastic or increases the size of the tissues which have to pass through the opening, can produce phimosis. Under the first heading come chancres and chancroids. With the former, especially, we often see a temporary phimosis when the chancre is on either layer of the foreskin. It is less common with chancroid, if we except those cases in which there is a great deal of inflammatory reaction. Verrucæ may be a cause when they are situated on the foreskin itself and are so considerable as to produce appreciable thickening and loss of elasticity; or they may produce the same effect when they are situated on the glans and are large enough to increase its size greatly. Ulcers from whatever cause may act in the same way as chancroids.

The presence of a sarcoma or a cancer may result in inability to retract the foreskin. In these diseases the disability may arise either from diminished elasticity of the prepuce or from increased size of the glans, or, what is more common, from a combination of both.

The various acute inflammations may also act as causes of the acquired form of phimosis. For example, it not infrequently happens that, when a patient with a redundant foreskin has an acute gonorrhœa, there is so much swelling of the tissues of the foreskin that it is utterly impossible to retract it. There is usually a marked balanitis or balano-posthitis in these cases. Balanitis without an accompanying gonorrhœa may give the same result. In fact, some of the most difficult cases to treat come from repeated attacks of balanitis. Not only may the opening be narrowed down to a small, hard, cicatricial ring, but the inner layer of the foreskin may become so adherent to the surface of the glans that a careful dissection is necessary in order to free it. There is often a history of repeated attacks occurring from infancy on, and characterized by a gradually increasing phimosis.

Pathology.—The action of scar tissue is the same in the foreskin as elsewhere, and to cicatricial contraction are due most of those cases of acquired phimosis which are not immediately dependent upon one of the acute inflammations or upon the presence of a new growth. The loose cellular tissue lying between the two layers of the foreskin readily lends itself to any process that gives rise to œdema, and comparatively slight and rather remote sources of infection may result in considerable swelling of the prepuce.

Diagnosis.—The diagnosis is easy. It is a simple matter to determine whether the prepuce can or cannot be retracted over the glans.

Symptoms.—There are often no symptoms. Many men go through life with even a rather tight phimosis and never have any ill effect from it. Babies may have trouble in urination even amounting to retention. The foreskin may balloon out with each micturition to several times its normal size. There can be no doubt that the straining caused in trying to pass water is one cause of hernia in babies. What usually calls attention to the condition is the frequent recurrence of attacks of slight inflammation. The foreskin cannot be retracted so as to cleanse the glans properly and the retained smegma sets up an irritation which may vary in degree from a slight itching sensation to an acute inflammation with a profuse purulent discharge. In patients with a very small external opening we may have formation of calcareous deposits in the preputial sac.

A tight foreskin, either with or without adhesions, has to assume the responsibility for a multitude of so-called reflex symptoms in children. One cause of masturbation is undoubtedly the irritation caused by retained secretion which induces the child to rub the genitals. This indirectly may lead to irritability, but it is hard to see how a tight foreskin alone can lead to convulsions and epilepsy, except in the presence of a very unstable nervous condition. Pruritus scroti and enuresis have been cured too many times by circumcision to leave any doubt that in many of these cases phimosis was the cause of the symptoms.

Treatment.—The treatment is more or less dependent on the cause. If it be a congenital phimosis, without inflammatory complications, stretching the opening may be tried. Various dilators have been devised for this purpose, but the best is the glans itself. Attempting to draw back the foreskin forces the conical end of the glans into the opening and stretches it better than can any metal dilator. This method is painful, tedious alike to operator and patient, and, after all, inefficient in any but the simplest cases. It should not be persistently tried, except where operation is strongly contra-indicated. If the phimosis be acquired and be due to inflammatory exudate alone, syringing out the foreskin with warm boric acid or a weak permanganate solution, or even with salt solution, may effect a cure. A soft, pointed syringe should be used and care taken to avoid traumatism. Soaking the penis in hot boric solution may also prove helpful.

Usually some cutting operation is needed. This may be done either with or without an anæsthetic, according to the age and condition of the patient. The operation selected may be either the dorsal slit, the two lateral slits, or a circumcision. Of these, the dorsal slit may be done without anæsthesia or with local anæsthesia. Taylor's operation, where two lateral slits are made, is not much more painful than the dorsal slit. A regular circumcision, except in young babies or adults with an extraordinary amount of fortitude, requires some kind of anæsthesia. For young children cocaine is not very satisfactory, but for those who are able to exercise some self-control, it is excellent. It may be used in a weak solution, one-half of one per cent being very efficient. If the penis be wound from before back with a rubber bandage so as to render it bloodless, and a tight rubber tourniquet be applied at the base, the action of the cocaine is more efficient. If too tightly applied the tourniquet may give more pain than the operation. In injecting the cocaine solution it must be borne in mind that the frenum is the most sensitive place. It is well to begin to inject on the dorsum at the muco-cutaneous junction and force the needle back slowly toward the corona. If the point of the needle is not pushed ahead of the wheal which the cocaine raises as it is injected, there need be no sensation of pain after the first prick. If the foreskin is simply to be slit open upon the dorsum this single anæsthetic line will be enough. For a complete circumcision the cocaine should be used more freely. After anæsthesia is quite complete, some of the solution should be injected into the frenum itself. If this is done slowly and carefully there will be no pain. If a small amount of a five-per-cent solution of cocaine is injected into the preputial cavity and retained at least five minutes before the cocaine is injected subcutaneously, it adds to the comfort of the patient during operation.

As a general anæsthetic, ether or chloroform is needed. Gas or ethyl chloride locally are satisfactory for the dorsal slit or the lateral operation, but their effect is not lasting enough for a careful circumcision.

In making the dorsal slit to allow of retraction of the prepuce, great care must be taken that the blade of the scissors is between the glans and the foreskin and not in the urethra. If the operation is done without an anæsthetic, the blade of the scissors which goes inside should be sharp at the point. It should be introduced as far as the corona, then forced quickly through the foreskin, and the operation completed by a rapid cut. If the hemorrhage does not stop quickly, the bleeding points should be secured and tied with catgut. In children this operation alone often gives perfect results. The two redundant flaps gradually retract and the cosmetic effect is often perfect. In other cases the excess of tissue can be removed, according to the method to be described later, either immediately or after a long enough time has elapsed to show whether the flaps will retract by themselves. In certain cases the diamond-shaped wound in the retracted foreskin may be sutured. This method is particularly applicable to those cases where the foreskin is short and the opening narrow.

Where it promises good cosmetic results, the dorsal slit is the operation of choice; but in patients with long prepuces it is apt to leave a ragged result which later will require further operation. As a temporary relief of phimosis due to inflammatory condition it is of great value. It is not possible properly to treat a balanitis or balano-posthitis or chancroids or chancre or any ulcerating process about the corona, unless the prepuce can be retracted. The dorsal slit usually affords ready access to the seat of the trouble. In the presence of great swelling of the tissues the dorsal incision will not give sufficient exposure of the diseased parts. In these cases the two lateral incisions, as advocated by Taylor, give a better view. The technique of the operation is much the same as that for the dorsal slit. The sharp blade of the scissors is introduced into the preputial sac as far back as the corona glandis, but on the side instead of on the dorsum. The point is then rapidly forced through and the cut completed. The same thing is done on the other side of the glans. This makes two flaps, an upper and a lower, and gives a particularly good exposure of the tissues about the frenum. It is a temporary expedient only and requires removal of the redundant flaps later.

Circumcision without the Use of a Clamp.—Many slight changes in the technique of the operation of circumcision have been devised, but the simplest methods are still the best. The clamp may or may not be used, at the option of the operator. If no clamp is employed, the point of a director is introduced in the median line as far as the corona and any adhesions which may exist are separated. The sharp-pointed blade of a strong pair of scissors is then introduced either on the director as a guide or after its withdrawal. The prepuce is then slit back to a point just in front of the corona. The foreskin is drawn back and adhesions are separated so as completely to uncover the corona, especially in the neighborhood of the frenum. We generally find here a collection of smegma. The whole field should then be again disinfected, preferably with a sixty-per-cent solution of alcohol. The skin cut will usually be found long enough, but the mucous membrane is rarely divided far enough back. The incision in the mucous membrane should be carried back to within about a quarter of an inch of its attachment about the neck of the penis. An assistant should now grasp the foreskin with forceps at the frenum and at the upper angle of the incision. The forceps at the angle of the incision should carefully approximate skin and mucous membrane. Traction should now be made on both pairs of forceps so as to put the flap of foreskin on the stretch, and the redundant portion between the forceps should be cut off with one sweep of a sharp pair of scissors. If the tissues are cut off in several pieces, it is hard to get a straight line, and the apposition of the edges will not be as perfect. The same procedure is adopted on the opposite side of the glans. If the prepuce be very long, there will probably be too much tissue left in the neighborhood of the frenum. This must be divided and the mucous membrane dissected off to within a quarter of an inch of its point of origin. The arteries of the foreskin are branches of the dorsal artery of the penis and circle downward and forward in the loose cellular layer. This connective tissue should not be cut away, but accurate hæmostasis must be established, as the nature of the tissues offers little resistance to the formation of large hæmatomata. Fine catgut is the best material for ligatures.

Two good-sized arteries are constantly met with at the frenum. When these are cut, they must always be tied carefully or included in one of the sutures. In children healing is rapid and the result good, even if no sutures are used. It is best, however, to catch the skin and mucous membrane together at at least four points, *i.e.*, at the frenum, in the middle line on the dorsum, and half-way between these two stitches on each side. In adults, where the danger of tension on the stitches from erection is greater, it is well to use horse-hair or fine silkworm gut at the four points mentioned. We may secure perfect coaptation of the edges by a running suture of number 0 plain catgut. In children catgut is sufficient for all sutures and is to be preferred, as it holds long enough to insure proper healing, and we avoid a struggle when the stitches have to come out. The dressing will be explained later, after the operation with the clamp has been described. The clamp operation differs only in detail.

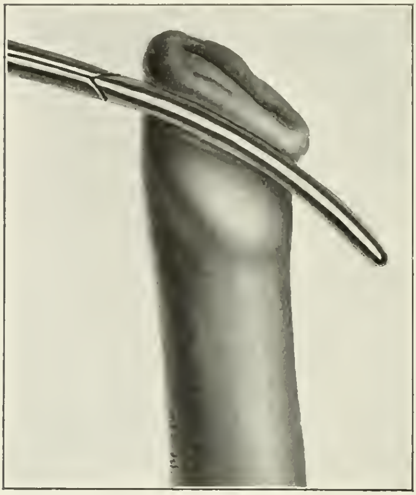

FIG. 456.—Circumcision with the Aid of a Clamp; First Step. Clamp placed obliquely.

The Clamp Operation.—Various instruments have been devised for this operation, some of which are perforated to allow sutures to be passed through. Some are curved and some straight. Hemorrhage is slight, so the hæmostatic effect of the forceps amounts to little. On the other hand, if the perforated forceps are used and sutures passed through them and tied at once when the forceps are removed, too much mucous membrane is sure to be left. The main object of any instrument is to give enough pressure to hold the two layers and insure a smooth symmetrical wound when the portion beyond the forceps is cut away. A pair of dressing forceps or, better, a long pair of clamp forceps curved on the flat (Fig. 456), serves well. This clamp is lightly pressed on the foreskin from a point half-way back on the dorsum of the glans and on a line in a general way parallel with the corona. On the under surface of the prepuce the instrument should be at a point just in front of the meatus. This insures a skin flap long enough to cover the sensitive papillæ of the corona. Before the foreskin in front of the forceps is removed, make sure that all of the glans is back of the instrument. The portion of the prepuce in front of the clamp is next cut off from above downward. This is best done with a sharp knife. After the clamp has been removed and the skin allowed to retract, the mucous membrane is next cut away until there remains only a narrow strip about a quarter of an inch wide, or just enough to sew the skin flap to. This removal of the mucous membrane is very important. Jackson and Stewart mention the compression of the mucous membrane as causing erections, especially in adults. This seriously interferes with healing. Unless the mucous membrane is entirely removed, some phimosis is sure to persist and the trouble may increase as time goes on. The point on the under side of the skin flap is now carefully adjusted to the mucous membrane of the frenum and approximation of the skin and the mucous membrane secured all the way around by catgut stitches. (Fig. 457.) It is best, after the middle line below has been fixed, to put a stitch in the middle line on the dorsum. The edges may then be united all around either by a continuous or by an interrupted suture. If interrupted sutures are used, it is easier to remove one and let out a hæmatoma, should one form; but, if hæmostasis is carefully attended to, this should not be necessary. With children little or no dressing is required. The wound may be dusted with boric acid. In adults the dressing is of more importance. After dusting the line of incision with boric-acid powder, a narrow strip of absorbent gauze should be laid over the cut. (Fig. 458.) The frenum should rest on the middle of the strip. The two ends should then be wound about the penis, just back of the corona, in such a manner as to cover the incision. The two sides cross on the dorsum, figure-of-8 fashion, and the ends are fastened down on either side of the penis with a little flexible collodion. This makes a very simple covering and stays in place well. Some operators prefer to draw the foreskin forward as far as it will go, thus leaving the line of incision covered. The same gauze-strip dressing can be applied in these cases also. It may be necessary to use collodion at a few more points in order to make the gauze hug the glans closely.

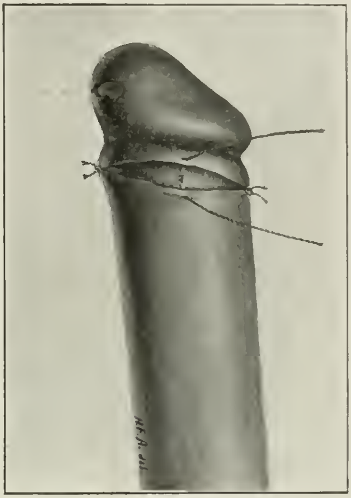

FIG. 457.—Circumcision; Second Step. The prepuce has been removed and the cut edges are being approximated with interrupted sutures.

If erections follow the operation this dressing offers considerable obstruction to the swelling of the parts and the discomfort usually awakens the patient in time to prevent damage to the sutures.

Another dressing that serves the same purpose in preventing swelling, has been described by Dr. Charles A. Porter, of Boston, Mass. After laying a narrow strip of gauze over his incision, he envelopes the whole penis, from a point just back of the meatus to the base, with adhesive plaster. This is applied in strips beginning on the glans and working back. The bands are applied in much the same manner as is the strapping on a sprained ankle, and the whole penis is put in a plaster splint so to speak. After four or five days, the plaster is cut off and no further dressing is required. If a strip of gauze is laid along the penis from back to front, so that something intervenes between skin and plaster, it is easy to cut down this dressing along that line. Zinc oxide adhesive plaster is the best for this dressing.

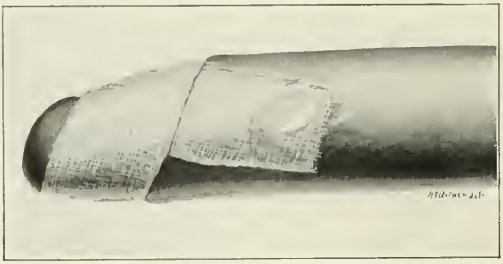

FIG. 458.—Circumcision; Third Step. Gauze dressing; collodion.

If no supporting dressing is used, there is often great œdema, more especially in the neighborhood of the frenum. In children this soon subsides, but in adults a troublesome thickening may persist for a long time. To keep the urine from wetting the dressing, boric-acid ointment may be used, or a piece of oiled silk or a rubber dam, with a hole cut to fit over the meatus, may be bandaged over the penis after the rest of the dressing has been applied. The ointment is useful, but the other devices are liable to become displaced; and, if urine gets back of them and wets the dressing, the impervious covering keeps the wound moist. If care is taken in micturition the gauze need not be wet. Whatever style of dressing is used, the penis should be held upright afterward by a T-bandage. This prevents irritation and lessens the œdema. If nonabsorbable sutures are used, they should be removed after three or four days. Catgut sutures need no attention, unless chromicized gut has been used. These may require removal.

Rest in bed for twenty-four hours is most desirable, though not absolutely essential. Remaining for forty-eight hours in the recumbent position hastens recovery and lessens the danger of complication.

There may be retention of urine, though this is very rare except in children.

Paraphimosis.—Paraphimosis is a condition in which the prepuce has been drawn back of the glans and cannot be carried forward again.

Etiology.—In the case of a very narrow preputial opening, paraphimosis may occur during coitus; but the condition is usually due to chancre, chancroids, or verrucæ. It is not an uncommon complication of an acute gonorrhœa. In children it is seen when the foreskin has been drawn back either in play or in masturbation. It may have moved over the glans with difficulty and some pain, and the child, afraid to say anything to his parents, may have allowed the condition to exist for some time. The tight constriction about the penis causes all the parts beyond the band to swell and the result is a paraphimosis. It is sometimes seen after circumcision when very little of the foreskin has been removed and the swelling of the tissues has been so great that a constriction of the penis occurs.

Pathology.—As the amount of swelling depends on the tightness of the constricting band, it follows that we may find a condition varying anywhere from slight œdema of the tissues to an ischæmic necrosis of all the structures beyond the constriction. In children and strong adults the condition is seldom accompanied by sloughing; and if in aggravated cases this does occur, the constricting band goes first and thus brings about its own cure. A certain amount of ulceration where the band is tightest is common; and if the paraphimosis be reduced without operation, the resulting contraction of scar tissue is one of the causes of subsequent complete phimosis. In ill-nourished or diseased persons the more extensive degrees of sloughing may be met with.

Diagnosis.—The diagnosis is generally easy. In persons who had already been circumcised, a localized swelling of the end of the penis might give rise to some difficulties. This history is usually enough to put one on the track. The patient almost invariably tells of a rather tight foreskin and of previous trouble in retracting it. The acute trouble usually follows the act of drawing back the foreskin to cleanse the surface beneath it. Having retracted it, the patient is not able to get it forward, and the ensuing œdema rapidly increases the difficulty.

Treatment.—Before reduction is possible, the swelling of the tissues beyond the constricting ring must be diminished. This can be done only by pressure on the glans and the œdematous layers of the foreskin. A rubber bandage may be applied from the end of the glans back to the pubes. This should be as tight as the patient can bear and should remain in place several minutes. It should then be rapidly unwound and reduction attempted. Steady pressure with the hand will accomplish the same result.

After the swelling has been partly reduced, an attempt should be made to draw the prepuce forward over the glans. Both hands must be used. The two thumbs force the glans back while the middle and fore fingers draw forward the prepuce. (Fig. 459.) Pressure should be so directed as to push the corona back and under the constricting ring. Though painful, this manœuvre is usually successful. If it prove unsuccessful and if no immediate danger threatens should action be delayed, the penis may be soaked in hot water or hot compresses may be applied or further steady pressure may be employed. Heat is preferable to cold. If, after reasonable delay, there is no relief, or when the symptoms are urgent, operation is necessary. It is not an easy matter to reach and divide the constricting band. Buried as it is in the œdematous folds of the tissues, it is a painful process to bring it into view so that it may be cut. A blunt-pointed bistoury with the edge turned sideways may be passed under the band. The edge of the blade is then turned up and the ring cut. A better way is to cut down on the band from above. In the presence of as much inflammation as is usually present, it is safer to delay a regular circumcision for a more favorable time, but it can be done at once when occasion requires.

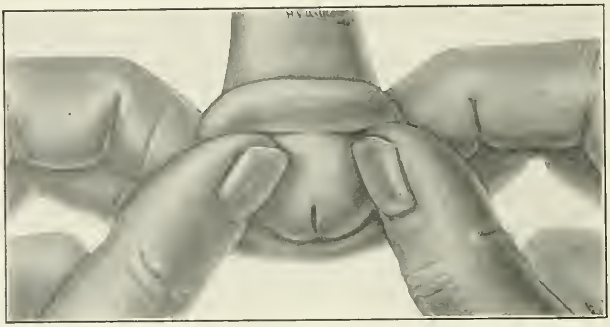

Fig. 459. Reduction of Paraphimosis.

No dressing is required after a simple reduction, but the penis should be held upright by cotton or gauze and a firmly applied T-bandage.

Congenital Circumcision.—Congenital circumcision is exceedingly rare. In a case that recently came to the writer's attention, the child of an Irish woman by a Hebrew father was born with a foreskin as short as if it had been circumcised. Whether paternal heredity had anything to do with this, cannot be said; but at least the instance goes to controvert the familiar assertion that protracted racial custom has no influence on anatomical structure.

Malformations of the Urethra.—Malformations of the urethra, with the exception of epispadias and hypospadias, are extremely uncommon.

Complete Absence of the Urethra.—This malformation is very rare. There are a very few instances in which the anterior portion of the urethra has been absent; but a true absence of the whole urethra has been doubted, because the observations have not been confirmed by autopsy. Kaufmann recognizes a case reported by Pigné to be authentic and proven.

Closure of the Urethra.—Complete obliteration is rare, and is due to an arrest of development from unequal growth of the various parts of the penis. When the obliteration is partial, the external meatus is so small as to cause obstructive symptoms. Complete obliteration may be due merely to an imperforate skin at the meatus, or it may be more extensive and involve the urethra itself for a considerable distance.

Small Meatus.—It is a somewhat difficult question to determine just when a narrow meatus constitutes a pathological condition. Some men have an opening which just admits a probe, yet this narrowing has never given them any trouble until a gonorrhœa, or other inflammatory process, causes swelling enough to make micturition difficult or impossible. Marked obstruction at the meatus gives back-pressure on the bladder and ultimately on the kidneys, just as a stricture does in any other part of the urethra. In addition to its mechanical effects, a small meatus has often been held accountable for nocturnal enuresis and various reflex symptoms in children. Apart from the few examples of actual obstruction, it is often necessary to enlarge the opening in gonorrhœa, either to allow a freer exit for the discharge or to permit the introduction of instruments.

Meatotomy.—The operation for relief of a narrowed meatus is known as meatotomy. Dilatation may be tried, but is tedious and painful. Meatotomy is simple. It is best done with a blunt-pointed bistoury, and the cut should be made large enough to admit a sound at least one size larger than the opening desired, as cicatricial contraction will reduce the size of this opening somewhat. If the anterior inch and a half of the urethra is injected with a five-per-cent solution of cocaine and the fluid retained for five minutes, the operation is nearly painless. If a few drops of one-per-cent cocaine be injected at the meatus in the line of the frenum no pain will be experienced beyond the initial prick of the needle. The cut should always be made in the median line on the floor of the urethra. The opening should be made no larger than is necessary, as cases have occurred when the relaxation of the frenum coincident with an unnecessarily extensive operation has markedly interfered with the sensations during coitus.

As an after-dressing, it is well to twist into the meatal orifice a cone of cotton well covered with boric-acid ointment. This dressing is renewed by the patient after micturition. The tendency is for this opening to close, and, unless a patient is unusually conscientious in the introduction of the plugs, the meatus will probably have to be dilated with sounds three or four times in the course of the next ten days.

Hemorrhage is the only complication likely to arise, and that can be easily controlled by pressure and a T-bandage to hold the penis upright against the abdominal wall.

Dilatation of the Urethra.—This condition of the urethra is described, in the case reported, as a dilatation which begins immediately behind the glans and extends to the peno-scrotal angle. The widening takes place at the expense of the inferior surface of the urethra, the superior surface being unchanged. The foreskin, glans, and external meatus have been found normal. The urine collects in the sac, whence it is slowly passed through the meatus. The sac is lined with mucous membrane. Several times valve-like processes have been found at the junction of the penile with the glandular urethra. It has been held that these valves prevented the free outflow of the urine, since the glandular urethra itself and the meatus were, in these cases, normal. Kaufmann believes that the cause of the urethral dilatation is probably to be found in some defect at the junction of the glandular and penile urethræ, a defect which still exists at the time when the urine first leaves the bladder and enters the urethral canal, and at a time, therefore, when complete communication has not yet been established between the two urethral segments. The stasis of the urine gradually causes a dilatation of the walls of the canal.

Treatment of the urethral dilatation has been successfully carried out, in several instances, by removing an oval section from the inferior wall of the diverticulum and suturing together the cut edges of the remaining portion of the canal.

Double Urethra.—This malformation (Fig. 460) is also a very rare condition, especially when the duplication is complete. True double urethra is found only with double penis. Usually one urethra is rudimentary; frequently one is above the other. Cases are seen also where the second urethra is only a superficial cleft, this cleft being usually on the glans; but it may stretch back over the penis and parallel the true urethra as far as the pubic region, where it may either end, or else connect with the true urethra. The false urethra may or may not have a superior opening. During micturition the urine first appears at the pubic opening of the false, and later escapes through the true urethra.

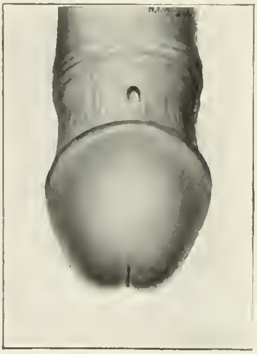

Fig. 460.—Double Urethra. (After Duhot.)

Hypospadias.—This is a malformation in which the urethra does not terminate normally, but opens on the inferior surface of the penis. The condition is named, according to the position of the external meatus, glandular, penile, or perineal. In the glandular variety of the hypospadias the meatus is found immediately behind the glans; in the penile, the opening is on the body of the penis; while in the perineal variety the cleft occurs somewhere in the perineum.

The etiology of hypospadias has been alluded to in the remarks about embryology. (Page 635.) An arrested or unequal development of the constituent portions of the penis leads to this anomaly. Reichel states that the degree of deformity is an indication as to the period in intra-uterine life at which the arrest took place. Perineal openings develop in the sixth or seventh month, and the glandular from the twelfth to the sixteenth week. In the glandular variety the penis is usually stunted and retracted downward, thus causing erection to be difficult. The site of the normal external urinary meatus is generally marked by a cleft or dimple which ends blindly in the tissue of the glans, or else a cleft or furrow may be found which runs backward through the glandular tissue until it meets the small round hole that indicates the beginning of the true urethra. In hypospadias of the body of the penis, the urethral opening is placed somewhere between the corona and the peno-scrotal angle. Anteriorly to the urethral orifice the normal site of the urethra appears only as a cleft which reaches forward for a short distance. The covering of this cleft is usually mucous membrane. The perineal type of hypospadias is very rarely seen, as it is due to a much greater fault of development. Here the scrotum and the urethra are divided into two parts, and, in the depths of the fissure thus formed, is situated the orifice of the urethra.

In the female, hypospadias may appear as a cleft on the under surface of the urethra. The milder degrees of hypospadias do not cause serious inconvenience; but in the advanced types the condition may interfere with erection and coitus, while the narrow urethral opening may cause the symptoms of stricture.

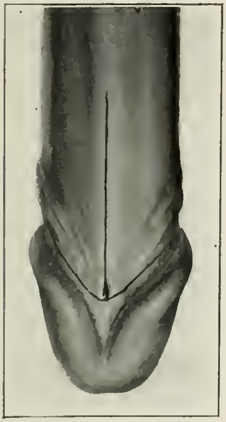

FIG. 461.

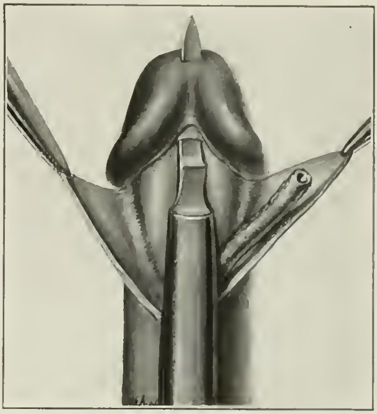

FIG. 462.

FIG. 461.—Beck's Operation for Hypospadias; First Step. Flaps marked out; longitudinal incision over the urethra; two lateral incisions joining the longitudinal at the hypospadiac opening.

FIG. 462.—Beck's Operation for Hypospadias; Second Step. The flaps have been dissected back and the urethra mobilized; the knife is shown making a new channel through the glans.

Charles H. Mayo quotes Kaufmann and Rennes as authority for the statement that hypospadias occurs once in every three hundred and fifty males, which renders the condition more common than is generally realized.

The treatment for hypospadias is wholly operative. Several operations have been devised for the cure of each type of the condition. Only the most successful will be described.

Beck's Operation for the Cure of Glandular Hypospadias.—Beck has had excellent results in curing glandular hypospadias by employing the following technique:—Exposure of the urethra by dissection of the skin (Fig. 461); mobilization of the urethra; tunnelling of the glans with a knife (Fig. 462); urethra drawn through hole in glans and sutured in place (Fig. 463); skin flaps replaced and sutured (Fig. 464). The exposure of the urethra is accomplished as follows:—A longitudinal skin incision is made over the urethra, extending backward from the urethral orifice at the base of the glans for about two and one-half inches. Two lateral incisions are then made, starting at the junction of the longitudinal incision with the external urethral opening. Each cut passes outward, skirting the corona glandis for approximately one-third of the circumference of the penis. In this manner are marked two triangular flaps which, when dissected away from the subcutaneous tissue, allow a free exposure of the lower end of the urethra. The meatus is separated from its relations and the whole urethra dissected from the surrounding tissue and laid back. It is now necessary to make a new passage through the glans. A narrow-bladed knife is chosen for this purpose, and a stab-wound made from the inferior surface at the base to the apex of the glans. The point of emergence of the knife may not be exactly at the apex of the glans, since it is occasionally found preferable to place the new external meatus on the superior surface of the glans, near the apex. (Ochsner.) This variation is introduced to overcome the persistent bending downward which often accompanies this anomaly. The freed urethra is now stretched along its future bed and drawn with forceps through the newly formed glandular tunnel; there it is fastened in place with interrupted stitches which attach the circumference of the urethral mouth to the adjoining cut edges of the glandular opening. Before this wound is closed, the urethra is carefully inspected, and any possible source of future retraction overcome by mobilizing it still more. The urethra is finally covered in by the triangular skin flaps. These flaps are sewed into their original relations with either continuous or interrupted stitches.

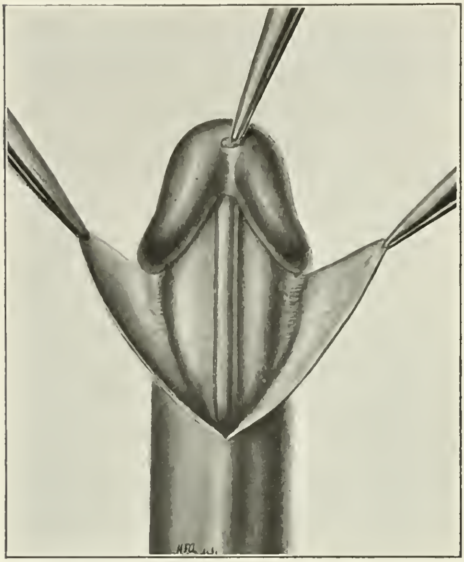

FIG. 463.—Beck's Operation for Hypospadias; Third Step. The urethra is here represented as having been drawn through the new glandular canal. The external meatus is placed on the dorsal side of the apex of the glans. It is shown in the drawing on the ventral surface in order to get all the technique of this step upon one illustration.

In penile hypospadias a more complicated state of affairs is usually found. The orifice is situated at a distance from the glans, a condition which in itself demands a more elaborate technique for its cure. Besides the above condition, however, the body of the penis is often found adherent to the scrotum, sometimes in such a manner as to cause a sharp downward kink of the whole penis. The adhesions and the kink must be remedied before any attempt is made to construct a new urethra. This may be done by the following steps:—Freeing the penis from the scrotum and straightening the organ; the formation of a new urethra; the union of the two urethræ. The penis may be separated from the scrotum by blunt dissection, and the denuded area thus resulting may be covered with a skin flap taken from the scrotum. The penis may otherwise be freed by a transverse incision (Boisson), which leaves a diamond-shaped denuded area when the penis is drawn forward. The denuded area on the penis may be covered with grafts, or the condition may be remedied by a plastic operation. C. H. Mayo states that this operation is best done at four years of age. In the construction of a new urethra a skin flap is utilized. The methods of securing the flap are numerous, and none is suitable for all conditions. Duplay and Thiersch make longitudinal incisions on either side of the urethral groove, leaving a strip about one-half inch in width. This strip is wrapped around a catheter and sewed in this position. Transverse incisions at the ends of the original longitudinal urethral cuts permit the making of lateral flaps which are drawn over the catheter and there secured in place with mattress stitches. This operation is best done at the fifth or sixth year.

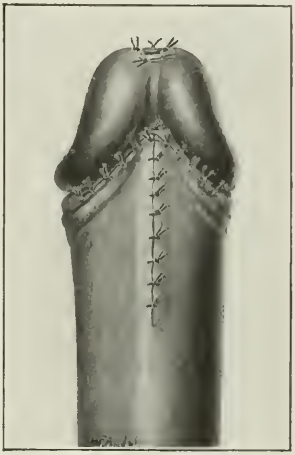

FIG. 464.—Beck's Operation for Hypospadias: Fourth Step. The end of the urethra is fastened to the new external meatus, and the skin flaps are closed over the mobilized urethra.

The union of the two urethræ is made some time after the first two steps, preferably at puberty, as the co-operation of the patient is essential to the success of the operation. The sides of the two urethræ are fastened and carefully sewed together. Constant bladder drainage is desirable. Beck and Rochet have each adopted, for closure of penile hypospadias, a technique in which the flap is taken from the scrotum. Beck, somewhat after the method of Duplay, makes a urethra from a scrotal flap, twisting the pedicle so as to turn the skin surface out. (Fig. 465.)

Rochet's Operation.—The steps of this operation are as follows:—The formation of a new anterior channel (Fig. 466); the taking of a longitudinal flap from the scrotum (Fig. 467); the sewing of this flap about a catheter, and the drawing it through a new anterior channel (Fig. 468). A transverse incision is first made in front of the hypospadiac opening about five-eighths of an inch in length.

On the under surface of the penis a channel is tunnelled out by blunt dissection to the base of the glans, whence it pierces the glans and emerges at its apex. A longitudinal flap is taken from the penis and scrotum, its base being placed at the orifice of the urethra. The skin is wrapped around a number 21 F. catheter and sewed in place with fine catgut. The catheter is tied in place with a catgut stitch. The catheter, with the newly-constructed urethra, is

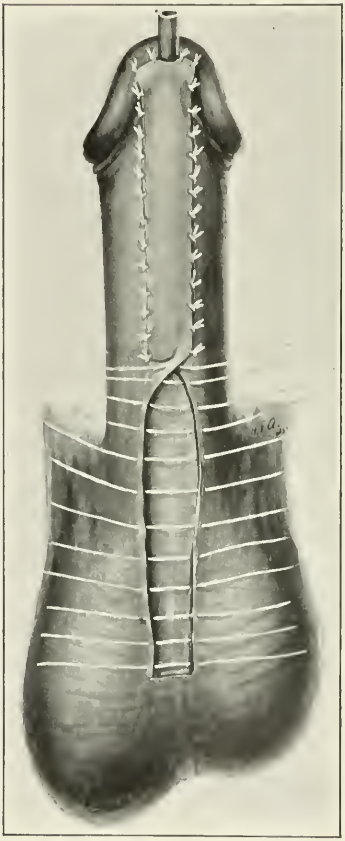

Fig. 465.

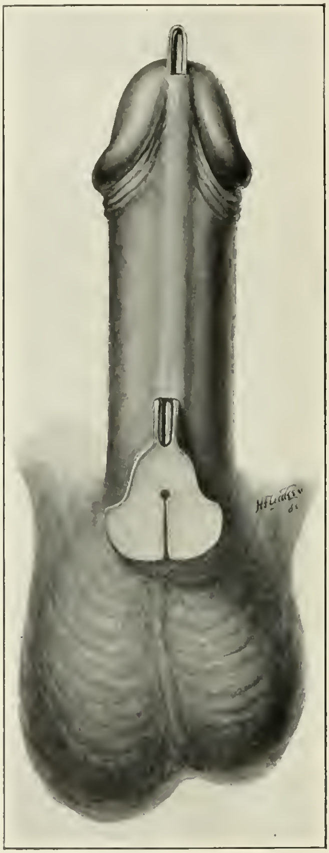

Fig. 466.

Fig. 465.—Beck's Operation for Penile Hypospadias. The flap, which has been taken from the scrotum to be utilized in making an anterior canal, is here represented as having been twisted upward, with its cut surface turned inward.

Fig. 466.—Rochet's Operation for Penile Hypospadias: First Step. Formation of new anterior canal.

now bent upon itself and carried forward and under the bridge of skin formed by the artificial channel previously made. The edges of the new urethra are sewed to the cut edges of the new glandular opening, and the catheter is pushed into the bladder.

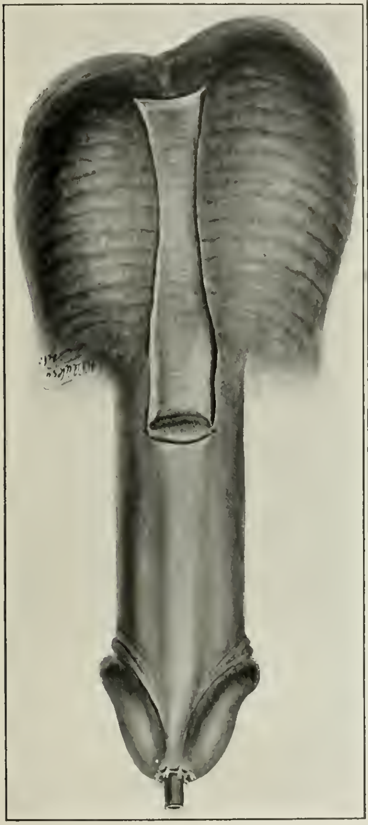

Fig. 467.

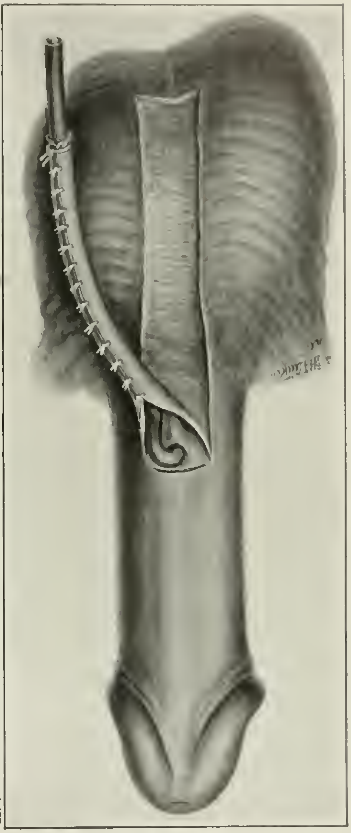

Fig. 468.

Fig. 467.—Rochet's Operation for Penile Hypospadias: Second Step. Longitudinal flap from the scrotum wrapped around a flexible catheter.

Fig. 468.—Rochet's Operation for Penile Hypospadias: Third Step. The flap has been drawn through the anterior canal on a catheter and then made fast by sutures.

The causes of failure are given by C. H. Mayo as follows:—The field of operation can be rendered sterile only with difficulty, and the flaps are often under too great tension. Under such circumstances, the soaking of the dressing with urine may lead to sloughing. The drainage of the bladder is difficult after the third day, since great irritation may be caused by the pressure of the catheter. This leads to straining, which may result in driving the urine along outside the instrument, or else may force the latter out of the bladder completely. Subsequent contraction of the dislocated urethra may pull the penis downward and cause the stream to be delivered downward in its original direction. Mayo advises the adoption of Thiersch's suggestion to establish constant drainage before attempting to suture the flaps.

Perineal Hypospadias.—This condition is generally associated with more or less marked pseudo-hermaphroditic forms and then seldom calls for treatment. Occasionally, however, it occurs in otherwise normal males with bifid scrotum, but with well-developed penis and testis. The perineal meatus may be single or double. Nové-Josserand describes an operation for the relief of this condition; it is done in three stages at three separate times. The penis is first freed from the adhesions which usually cause it to curl downward, is then straightened, and finally is allowed to heal. At the next operation a subcutaneous tunnel is made from the abnormal meatus forward along the ventral aspect of the penis to the base of the glans, and an anterior urethra is constructed by placing in this tunnel an Ollier graft taken from the thigh and rolled on a sound with the skin side facing inward. While this graft is healing in place, the bladder is drained by a catheter passed through the perineal meatus. At the final operation the remaining defects are closed, the posterior urethra is united to the anterior, a glandular meatus is constructed by the method described above (page 650), and the halves of the scrotum are refreshed and united. A troublesome fistula may persist at the site of the old meatus.

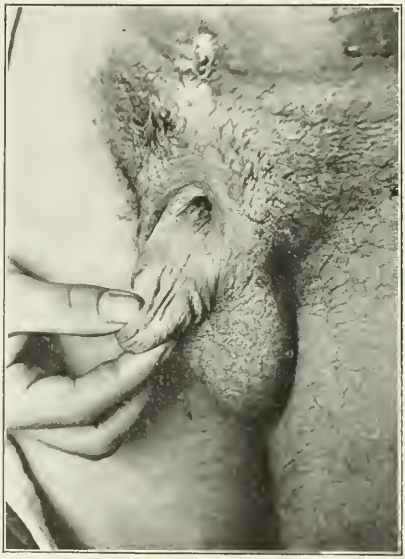

FIG. 469.—Epispadias. (Courtesy of Dr. Charles L. Scudder, Massachusetts General Hospital.) Note the typical situation of the opening, near the pubic bone. Above it may be seen the cicatrix of a wound made for a suprapubic cystotomy for stone.

Epispadias.—This malformation (Fig. 469) consists in a urethral fissure upon the superior surface of the penis. It is usually associated with exstrophy of the bladder, but may be confined to the glans or to the body of the penis; and when this is the case a part or all of the roof of the urethra may be absent. The opening is commonly found immediately in front of the symphysis pubis, though, in rare cases, the urethra may be intact up to the point where the corpus spongiosum expands to form the glans. Usually there is a defect in the pubic bones. In such cases the penis is likely to be short, broad, and sometimes twisted. There is a long prepuce below, while above there is often seen a fold of skin which projects from the abdominal wall, and partly or completely covers the epispadiac opening. The urethral orifice is large, while the urethra is continued for a certain distance forward as a furrow, deep posteriorly and shallow anteriorly, before it is covered with mucous membrane. Like ectopia vesicæ, it probably represents a vesical rupture or "blow-out" from the embryonic condition.

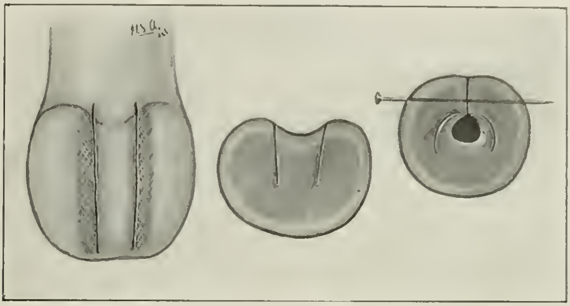

FIG. 470.—Thiersch's Operation for Epispadias; First Step. Parallel cuts into glans; glandular flaps, thus formed, sewed over the catheter.

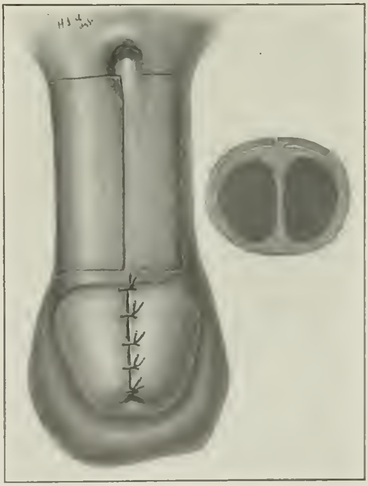

FIG. 471.—Thiersch's Operation for Epispadias Second Step. Formation of penile urethra, incisions.

Treatment.—Kaufmann, in the *Deutsches Archiv für Chirurgie*, 50, a., cites two types of operations which are available for the closure of epispadiac clefts: (1) Median closure of the freshened borders of the cleft (von Dieffenbach); (2) closure of the cleft by skin flaps (Thiersch).

(1) von Dieffenbach's operation consists of the following steps:—The edges which border the penile cleft on the dorsum are freshened with scissors, and a sound or a catheter is introduced into the bladder. The borders are then drawn together over the cath-

eter. There are several methods of sewing the edges. Silver wire has been recommended as well adapted for use under these conditions.

(2) Thiersch's operation consists of the following steps:—Preliminary establishment of perineal fistula; formation of urethral canal in the glans; covering of penile cleft with skin flaps; coupling together of newly formed glandular and penile urethræ; and closure of space left between penile flap and pubis with abdominal flaps. In establishing a urinary fistula the finger or a sound is passed into the bladder and hooked backward so that the perineal rhaphe is made to bulge. The bladder is then opened from below and constant drainage secured. This preliminary procedure diverts the urine away from the field of operation.

The transformation of the glandular cleft into a closed section of the urethra opening upon the apex of the glans is done in the following manner:—Two parallel incisions are made, one on each side of the glandular cleft. (Fig. 470.) The planes of the incisions converge slightly as they enter the deeper portions of the glans. The glans is thus converted into two lateral flaps enclosing a central wedge-shaped portion. The superficial surface of the glans which borders the cleft is denuded for a short distance parallel to and outside the cuts, and these superficial refreshed areas are turned over inward and placed face to face, thus covering the wedge-shaped central portion. The glandular flaps are sewed together over a catheter with a few stitches.

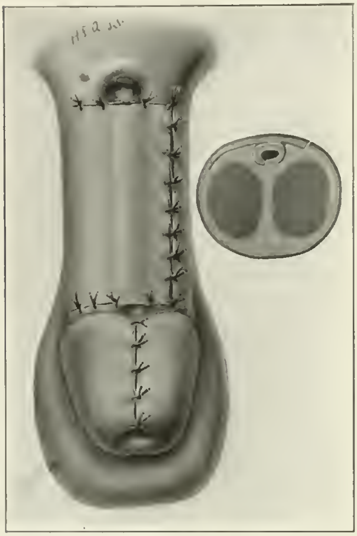

FIG. 472.—Thiersch's Operation for Epispadias; Third Step. Catheter in the bladder; overlapping flaps from body of penis form the penile urethra.

The conversion of the penile cleft into a urethra is accomplished by taking flaps from the dorsum of the penis, in the following manner:—A longitudinal cut is made parallel to and to the right of the cleft for its whole length. (Fig. 471.) Across the ends of this incision cross cuts are made to allow the flap to be lifted and reflected. A similar flap, about one-half the width of the first, is taken from the left side, with its base parallel with the adjacent cleft. These flaps are dissected up and drawn together over the cleft in such a manner that they convert the hollow gutter into a closed tube. They are fixed in place without tension, so that the denuded surface of one flap comes into apposition with that of the other, while the epidermal covering of the inside flap looks into the urethra. By this method of attachment the catheter is wholly surrounded by epithelium. (Fig. 472.)

The junction of the new glandular and penile urethræ is effected in the following manner:—The uncovered space which exists anteriorly between the two tubes is covered by prepuce. This is done by thrusting the glans through a window made in the prepuce, which hangs redundant below the glans. (Fig. 473.) The cut edge of the dorsal, or upper, fold of the prepuce is drawn apart to make two edges, one of which is attached to the glans, the other to the penile flap. This closes the gap between the penile and glandular portions of the new urethra.

To close the space left behind the penile flap, near the pubis, the neighboring abdominal skin is employed to furnish two flaps. (Fig. 474.) The first flap has the shape of an isosceles triangle, and is taken from the left side, its base occupying the left half of the space to be covered in. This flap is turned down in such a manner that the under skin surface faces downward over the urethral gap, and that the edge of this first abdominal flap can be attached to the posterior or free edge of the penile flap. The second abdominal flap comes from the right, its base being situated in the region of the inguinal canal. This flap is triangular, but it is longer than the first. It is drawn down toward the middle line over the first, so that the raw surfaces of the two flaps come into contact. Here the outer flap is made fast. The triangular space left upon the abdominal wall is covered with skin grafts.

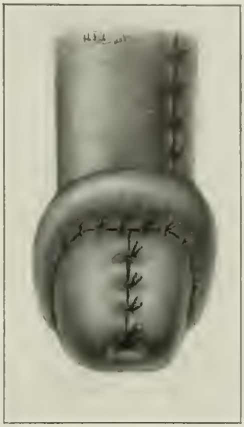

FIG. 473. — Thiersch's Operation for Epispadias: Fourth Step. The glans having been passed through an opening in the prepuce, the junction of the glandular and penile urethræ is effected by means of the cut edge of the prepuce.

The perineal fistula is kept open for fourteen days to give the various sections of the new urethra time to become joined. The last space to close is the posterior one, which requires, according to Thiersch, forty-two days. Several smaller operations may be demanded before the whole urethra is constructed, but the period of fifteen weeks is sufficient to complete the matter.

The end results are good. In cases where incontinence is associated with epispadias, Trendelenburg resects a small portion of the enlarged internal meatus, and, by drawing the edges together, constructs a smaller opening.

Malformations of the Scrotum.—Malformations of the scrotum are extremely rare.

Absence of the Scrotum.—Absence of the scrotum is unknown, except in connection with hermaphrodism, ectopia vesicæ, and total non-development of the sexual organs.

Rudimentary Scrotum.—Rudimentary scrotum may be unilateral or bilateral, and of all degrees, depending chiefly on the descent and development of the testes. When one testis is retained in the abdominal cavity or inguinal ring, the corresponding half of the scrotum is contracted and relatively scanty. But if the retained testis is later brought into its normal position by art or nature, the scrotum tends to enlarge to accommodate it. The size of the scrotum is always proportional and varies widely in different individuals. In some it is very snug, in other it ranges through all grades of voluminousness up to the extremely loose, baggy, pendulous scrotum which becomes a true hypertrophy of the scrotum.

Hypertrophy of the Scrotum.—Hypertrophy of the scrotum is most commonly associated with varicocele. When this laxity is excessive it becomes pathological; and amputation of the redundant scrotum has been advocated in connection with the operation for ligation of the spermatic veins. For this purpose a special curved clamp was devised by Henry in 1871. When this instrument is used, the testes are raised to a proper height and the clamp is applied below them in the median line with the tip close to the perineum. The superfluous portion of the scrotum included between the blades is then removed, and after careful hæmostasis the free margins of the wound are united by sutures. The testes are strapped and supported until healing is complete. The scrotum thus resected becomes a natural suspensory, and is supposed to prevent recurrence of the symptoms due to dragging and swinging of the testes. As a matter of fact, ligation and section of the veins afford such complete relief for varicocele that scrotal amputation is now rarely done in this country, though it has recently been revived by French surgeons.

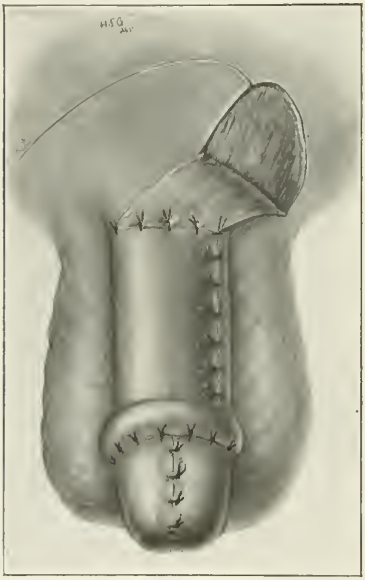

FIG. 474.—Thiersch's Operation for Epispadias: Fifth Step. Closure of epispadiac opening; flaps taken from the pubic region.

Bifid Scrotum.—Bifid scrotum, occurring in connection with perineal hypospadias, has already been described, and so also has been the operative treatment of the condition.

Dermoid Cysts of the Scrotum.—Dermoid cysts of the scrotum, similar to those described as occurring on the penis and prepuce, are sometimes found in the scrotum at or near the median rhaphe. Excision is the proper method of treating them.

Malformations of the Testes.—Under this heading will be considered absence of one or both testes, malposition of the testes, and multiplicity of testes.

Absence of Both Testes.—Absence of both testes, or anorchidia, is extremely rare, and almost unknown in otherwise well-developed subjects. Early reports of this condition probably represent unrecognized cases of bilateral cryptorchidia.

Absence of One Testis.—Absence of one testis, or true monorchidia, is equally uncommon, and most recorded instances of it are doubtless examples of unilateral cryptorchidism. Nevertheless, congenital absence of one or both testes may occur. In these cases, the corresponding cord and epididymis are usually present and in normal position. This condition should not be confounded with atrophy of the organs in adult life, following inflammation or senile decay.

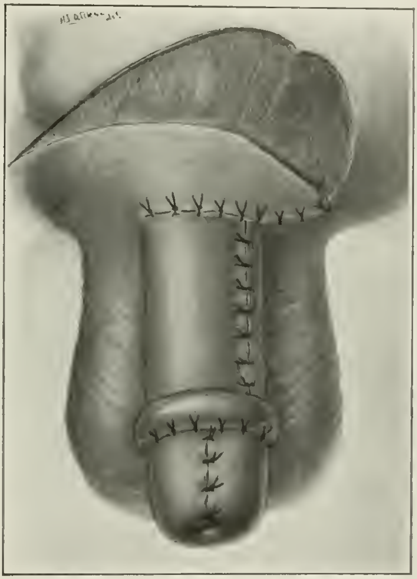

Fig. 475.—Thiersch's Operation for Epispadias. Sixth Step. Completion of plastic work over the pubic region.

Malposition of the Testes.—Malposition of the testes, commonly known as undescended testis, is relatively frequent, and presents an important problem of surgery. The subject has recently been well reviewed by Odiorne and Simmons.

It is difficult to ascertain how often an imperfect descent of the testis occurs. Statistics in adults are inaccurate, as men with this deformity would hesitate to present themselves for positions requiring a physical examination, and only those whose cases require help for some injury or inflammation would come to the attention of the surgeon. In infants, on the other hand, undescended testes which later come down to their normal position are so frequent that statistics are erroneous. Probably one per cent of all males are subject to this defect at some time during life. Spontaneous descent may take place at any time up to the fourteenth year; but if a testis does not come down within a year from birth, it seldom descends later.

Arrest of a testis in its descent is caused by some defect of development in embryonic or fœtal life, by inflammatory adhesions to adjacent structures, or by an adherent congenital hernial sac. In infancy and childhood a truss worn to hold back such an inguinal hernia may keep back the testis as well. It is doubtful whether heredity plays any part in the etiology of the condition.

Malposition of the testes may be unilateral or bilateral. It is much commoner on the right than on the left side. The testis may occupy several different situations, as, for example, within the abdominal cavity—true cryptorchidia; in the inguinal canal—partial descent; just below the external inguinal ring or in the extreme upper part of the scrotum. These positions are seldom constant, as one variety may readily pass into another. The testis may also wander out of its normal course and come to lie in Scarpa's triangle; in some part of the perineum (Fig. 476); or near the root of the penis or subcutaneously above the inguinal canal.

When the testis is in one of these last three positions, which correspond to the points of origin of the accessory fibres of the gubernaculum, the condition is known as ectopia testis, or aberrant testis. The inguinal variety is by far the most commonly seen; but this may be partly due to the fact that in this position the testis is most exposed, and injury would more frequently bring it to the surgeon's attention. Atrophy of the scrotum is most marked in those cases in which the testis is retained in the abdomen or high up in the inguinal canal.

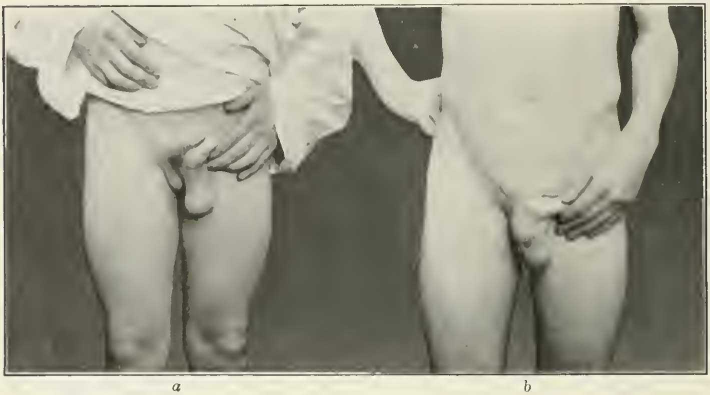

FIG. 476.—Testis in Perineum. (Case of Dr. Balch, Massachusetts General Hospital.) *a*, Before the operation; *b*, after the operation.

Halsted records a case in which, at operation for left inguinal hernia, both testes were found in the left half of the scrotum with fused epididymides and contained in a common tunica vaginalis. There were two spermatic arteries, and two vasa deferentia which united later, all of them contained in a single very large cord and lying in the left inguinal canal. The right side of the scrotum and the right inguinal canal were empty. This condition, termed *ectopia testis transversa*, is exceedingly rare, only two other similar cases, both also on the left side, having ever been reported in the literature.

SYMPTOMS.—As a rule, there are no symptoms directly traceable to the position of the testis except in so far as its position exposes it to trauma. Contractions of the abdominal muscles squeeze it, and in the event of any inflammation the unyielding tissues surrounding it resist and swell to such an extent as to cause intense pain.

Physiology.—An undescended testis is almost invariably imperfectly developed and is very seldom capable of producing spermatozoa. Some of these organs are imperfectly developed from the beginning, while others, though of normal structure during childhood, undergo none of the usual changes at puberty. Again, the function of spermatogenesis may be retained for a short time after its establishment, but it is doubtful if the function is ever retained after the age of thirty.

Pathology.—In some cases there is little if any change in the gross appearance of the organ. In childhood the change is essentially a fibrous one. The organ may closely resemble a fibroma, with none of the normal testicular structure demonstrable even under the microscope. In adults, if the testis be at the base of the scrotum, or even in the groin, it may vary in gross very little from the normal, but is usually flaccid and small. There may be slight malformation of the epididymis, though its vas is generally normal. Microscopically the fibrous tissue is generally increased and there are other changes in the tubules; there is also an increase in the number of the interstitial cells.

Complications.—Acute inflammation of an undescended testis may occur in the course of a gonorrhœa or an attack of mumps, and chronic inflammation may be the result of tuberculous or syphilitic infection.

Hernia is the most common complication. This is easily understood, as the processus vaginalis is seldom obliterated and its descent into the scrotum precedes that of the testis. The hernial sac is thus formed and at times the testis seems to act as a ball valve, holding the intestine in the sac. Inguinal hernia is certainly more apt to become strangulated when associated with an undescended testis. Interstitial hernia is also seen associated with this condition. The testis offers an obstruction to the descent of the hernia along the canal and its sac is forced out between the layers of the abdominal wall. If the funicular process is obliterated a simple hydrocele may occur. Torsion of the cord is rare, but about fifty per cent of the reported cases have been in undescended testes.

The question of malignant disease in an undescended testis is very important. The older writers believed that such organs were a source of danger as the possible seat of malignant disease later. Eccles, on the other hand, believes that no sufficient proof of this exists. Odiorne and Simmons report two series of cases in which the percentage of arrest of descent was eleven per cent and twelve per cent respectively. Sarcoma is probably somewhat more common in these abnormally placed testes. It is extremely rare in children. It is most often seen in inguinal testes, but has been reported a number of times in testes retained entirely within the abdomen. Metastasis occurs early and the course of this disease is seldom over a year.

Treatment.—Consideration of the age of the patient is of the utmost importance in determining the treatment of these cases. In infants at birth the testes are frequently undescended. No treatment is required unless the condition persists. During childhood the condition becomes more important as the chances of a spontaneous descent decrease. After the child has reached the age of eleven or twelve the chances are that the testes will never reach a normal position without interference. The period from eleven or twelve years to puberty is the most favorable for operation.

If the testis can, by manipulation, be brought down into the scrotum, traction should be tried frequently. Such measures seem to aid the testis in its descent. Up to puberty undescended testes rarely give trouble, but after the changes incident to this period these structures are much more liable to injury.

Operation.—There are three kinds of operation for the relief of undescended testis: orchidectomy, orchidopexy, and replacement in the abdominal cavity. If there is another normal testis, especially if there be a complicating hernia on the side of the undescended testis, orchidectomy may be done. Orchidopexy should be done whenever possible in childhood, and, before an orchidectomy is undertaken, it should be attempted in adults as well.

When the testis lies very high in the canal and cannot be brought down, it may be returned to the abdominal cavity. In no case should both testes in children be returned to the abdomen, as such testes are sure to be functionless.

In the operation of orchidopexy the canal is opened and the testis exposed The cord is dissected free and an attempt is made to draw the testis down. Considerable traction can be made without danger. If this does not give enough slack, the vas should next be freed, and, if necessary, traction made on that. As a rule, it is the shortness of the vessels that makes the trouble, and in extreme cases these may be cut, the testis being left to depend for its blood supply on the small artery which accompanies the vas. Such a procedure may lead to atrophy or gangrene of the testis. Bevan, however, as a result of a series of cases which he reports, states that all the vessels of the cord except the artery of the vas may be cut out without subsequent atrophy of the testis. He believes that this procedure, with thorough removal of the connective tissue of the cord, is an essential step in the operation of orchidopexy, when the cord is very short. If the shortness is caused by the vas, the epididymis may be partly dissected free from the testis and the organ inverted.

If the processus vaginalis has never been closed the sac should be divided, the upper portion being closed off by suture and the lower part stitched about the testis to form a tunica vaginalis. Traction is made on the cord and a suture is passed so as to fasten it to the aponeurosis of the external oblique at the external ring. The ring is closed in layers, but the cord is brought out of the lower end of the incision below both layers of muscle, and not between the layers, as in the Bassini operation for the radical cure of hernia. By avoiding the obliquity of the canal a quarter to three-quarters of an inch is gained in the length of the cord. A place for the testis must be made in the scrotum. This is easily accomplished with the finger. At times the testis remains in the new-formed sac, but as a rule a suture must be passed through the tunica albuginea and the tissues at the bottom of the scrotum. A pad and bandage should be so applied as to hold it in position. Almost always the testis later tends to draw up. This may occur soon or it may be a gradual process. Much may be gained by frequent traction on the cord during convalescence and for months afterward. In adults the testis may be replaced in the abdomen and the wall closed tight in cases where orchidopexy is impossible. This may lead to future trouble, as the testis may again find its way into the inguinal canal.

Results of Orchidopexy.—In most cases the testis can be brought down outside the external ring, even if it cannot be put in its normal position. This permits the repair of a complicating hernia. In such a position the testis may develop; but it is so constantly liable to trauma that most surgeons recommend its removal, if there be a normal one on the other side. Of 138 cases in children operated on by Bevan, 79 were followed for a year. Of these there were 31 in which the testes were of normal size and in normal position; 35 in which the testes were of normal size, but situated high up in the scrotum; and 13 in which these organs were atrophied. Coley operated on 38 patients, of whom 27 were children; all of them were under 30 years of age. In the paper of Odiorne and Simmons there are reported 24 orchidopexies on 22 patients, two of the cases having bilateral retention.

Multiplicity of Testes.—Multiplicity of testes, or polyorchidia, is so rare that only one authentic case can be found in the literature. Supernumerary testes to the number of four or five have been recorded; but such reports are undoubtedly fabulous or due to errors in observation, various tumors being mistaken for additional testes.

IV. TRAUMA.

Under the heading of trauma may be included: foreign bodies (both those encircling the penis and those lodged in the urethra); mechanical injuries and their consequences; and torsion of the cord, usually of traumatic origin.

Foreign Bodies.—Foreign bodies may be slipped over and around the penis intentionally or by accident; and, by interfering with the return flow of blood, may cause the penis to swell to such an extent as to make their removal impossible. When a ring is thus placed, the penis may be tightly wound, from the glans back, with a narrow bandage or tape, the end of which may be passed under the ring and the latter removed by forcing it forward as the tape is unwound. If the ring has been on for some time, and has ulcerated into the tissues, this manœuvre is impossible. In such a case the ring may be cut by a pair of pliers, or sawed through with a fine saw passed beneath it, the soft parts under the saw being guarded by a card or a piece of thin sheet metal. If the ring be of tempered steel, no file or saw will cut it. Such a ring, however, is brittle, and a very slight crush will cause it to break. Other bodies, such as a glass bottle or sledge-hammer head, must be removed with ingenuity suggested by the occasion. In the more difficult cases, cocaine or, if the patient be a nervous person, ether may be necessary.

Foreign bodies may enter the urethra either by descent from the kidneys or bladder, or by insertion through the external urinary meatus. Renal or vesical calculi, during their passage through the urethra, may become impacted and cause ulceration, at times even leading to infiltration of urine. It should be borne in mind that incisions made for their removal heal less rapidly in the pendulous than in the deep portion of the urethra. The author has seen very intractable stricture follow the removal of a stone through an opening just in front of the scrotum. When possible, calculi should be withdrawn by long forceps passed through the external meatus; but, if this fails, they should be pushed back into the posterior urethra and removed thence by external urethrotomy.

Foreign bodies of great variety may be introduced into the urethra, sometimes by children out of curiosity, more commonly by sexual perverts and others for purposes of sexual excitement. These must be dealt with according to the circumstances and the nature of the body in each case. Pins are generally introduced head first, and may then be lost and the point become driven into the tissues. In a case of this nature which came to our notice, a large pin which had advanced as far as the peno-scrotal angle was removed by grasping the head and forcing the point out through the urethra and corpus spongiosum; then the direction of the pin was reversed, the head was pushed out through the meatus, and the pin was easily withdrawn. In another case, the tufted end of a broom-straw, which had escaped from the fingers in which it was held, caused the straw to work up the urethra in the same way that an ear of wheat, placed up the sleeve with the bristles pointing down, will move steadily forward up the arm. This straw was recovered from the bladder, two weeks later, with a lithotrite. No injury befell the urethra beyond a tempory urethritis. Catheters and other instruments may be broken and their fragments left in the urethra. In one instance, the blade of an Otis urethrotome broke off and became deeply embedded in the soft tissues about the bulb. It caused no symptoms and was, therefore, left in place, since to search for it would have involved much more serious trauma.

Mechanical Injuries.—Mechanical injuries of the penis are not infrequently seen.

Laceration of the Penis.—Laceration of the penis may occur in any severe accident, and may be of all degrees. Owing to the abundant blood supply there is usually considerable hemorrhage, especially if the corpora cavernosa and corpus spongiosum are involved. The more severe injuries are often associated with a rupture of the urethra and accompanying infiltration of urine. Laceration may occur from unusual causes, as happened in a case seen at the Massachusetts General Hospital. The patient, a boy, while in swimming, had the foreskin so severely lacerated from the bite of a fish that circumcision became necessary. Horse-bite of the penis is also reported.

Crushing of the Penis.—Crushing of the penis may occur in railway injuries. In these cases the hemorrhage may not be severe even when trauma is extreme, the crushing being so complete as to give almost perfect blood stasis. In the so-called fractures of the penis, such as occur during violent coitus or through efforts to alleviate the pain and deformity in chordee, the corpora cavernosa are usually ruptured. In dislocation of the penis they become separated from their attachments to the pubic rami, so that the shaft of the penis may slip up under the skin of the abdomen. Such injuries are best treated by replacing the penis in its normal relations and securing it in the elevated position by some form of T-bandage till the injury is repaired. The prognosis for retention of function is good.

Stab Wounds of the Penis.—Stab wounds of the penis are sometimes met with. The hemorrhage from the clean-cut edges is severe and may rapidly cause death unless controlled by a tourniquet. Cases are on record where the penis has been severed from the body with rapidly fatal hemorrhage.

Gunshot Wounds of the Penis.—Gunshot wounds of the penis are not as frequently accompanied by severe bleeding as are punctured or stab wounds; but, on the other hand, they are more often followed by sloughing of tissues, cicatricial contraction, and consequent deformity.

In all penile injuries the prominent symptom is hemorrhage; consequently hæmatoma is of frequent occurrence. Often this will undergo complete reabsorption on treatment by rest, ice bags, and sedatives. At other times tapping may be resorted to, and less often it may be necessary to make a free incision, for the purpose of clearing out the clots and securing a bleeding point. The treatment in all cases should be directed toward the production of a clean wound; and the administration of sedatives, which give freedom from erections, aids materially toward a recovery. The bromides in large doses, or if necessary morphia, may be used for this purpose.

Following any of the forms of penile trauma, and determined by their nature and severity, there may be more or less deformity of the penis from cicatricial contraction, causing the shaft to curve downward or to deviate permanently to one side. Such deformity may be trifling or it may interfere seriously with function, making erection painful and coitus difficult or impossible. These conditions should be treated by an appropriate plastic operation, depending upon the particular nature of each case. The general principles involved are the freeing of adhesions, the division of contracting bands, the removal of scar-tissue as far as possible, and the application of grafts to denuded surfaces to prevent recurrences of the deformity when healing takes place.

Injuries of the Scrotum.—Injuries of the scrotum are to be treated on general surgical principles, but especial care must be given to hæmostasis. The tissues are so lax that a small vessel may lead to an extensive hæmatoma. (Plate XLVII, Fig. 3.)

Injuries of the Cord or Testis.—Injuries of the cord or testis may occur from any of the forms of trauma. Contusion of the testis may cause no damage to that organ apart from the agonizing pain. If the contusion is severe enough it may cause orchitis or more often an acute hydrocele. The outcome depends on the severity of the blow. In extreme cases it may lead to sloughing of the organ or subsequent atrophy. Incised wounds may give rise to a hernia of the substance of the testis, or, if the epididymis is involved, spermatocele may supervene later. In each case treatment must be determined by the particular conditions. In the clean-cut wounds of the cord, it is advisable to make an attempt at suturing the vas, if it be divided. Several cases are on record where this has been done, in some instances with apparent success. If the spermatic artery be cut, it is prone to retract, but must be followed up and ligated, even if it have to be pursued well toward its origin. The artery of the vas generally gives a sufficient blood supply for the testes after the spermatic artery is ligated.

Thrombosis of the Spermatic Artery or of the Pampiniform Plexus.—Thrombosis of the spermatic artery or of the pampiniform plexus may produce infarction of the testis. This may be due to infection or to trauma, but is typically seen in infants following breech delivery. There are swelling and phlegmonous appearance of the scrotum, with symptoms suggesting pelvic peritonitis. Treatment is expectant and symptomatic. Usually the swelling subsides, leaving in the testis a necrotic, wedge-shaped area, which cicatrizes, like an infarct of the kidney.

Burns and Frost-bites.—Burns and frost-bites of the male external genitals are uncommon, but may result in more or less serious loss of substance or subsequent cicatricial deformity. They should be appropriately treated as in other parts of the body.

Rupture of the Urethra.—Any accident in which a severe blow is received in the perineum may cause a rupture of the urethra. Falling astride the edge of a barrel or a beam is one of the commonest causes.

The course which the urine takes in extravasation cases is dependent on the relations of the injured part to the fascia. Thus, if the injury be at or in front of the bulb, the scrotum, the penis, or the abdominal wall will be involved. If it occurs posteriorly to the fascia, the spread will be back toward the rectum, the base of the bladder, and the peritoneum.

SYMPTOMS.—The most frequent sign of serious injury of the penis is bleeding from the meatus. There may be inability to pass urine or the patient may say that, after an effort, the water seemed to pass out from the bladder, but that little or none appeared at the meatus. The effort may have been accompanied by sharp pain and the appearance of increased swelling in the perineum. Efforts at catheterization may or may not have been successful. There is usually a tense dark swelling in the perineum. If this swelling exist, but without hemorrhage from the meatus, the urethra has probably not been injured.

TREATMENT.—In all cases where rupture of the urethra is suspected, perineal section should be done, the clots cleaned out, and the ends of the ruptured part of the urethra sutured accurately together. It is not possible to determine the extent of the injury of the urethra by means of an instrument passed in from the meatus. Even when a catheter can be passed into the bladder simple drainage is not sufficient. Leakage of urine over the torn surface tends to form a stricture. No better evidence of this is needed than the history of a case reported by Dr. A. T. Cabot in the Boston *Medical and Surgical Journal* of November 21st, 1901. Two months after treatment of a torn urethra by the so-called conservative method of fastening in a catheter, the patient had a tight stricture at the point of rupture. Dr. Cabot did a resection of this stricture with suture of the urethra. In some cases the operation is easy, but in others, where the bleeding has stopped and the bladder is empty, it may prove extremely difficult.

The usual cut for perineal section is made and the clots are turned out. In many cases the bulb will be found torn completely across. The distal end of the urethra is readily found by introducing an instrument from the meatus. The shrivelled proximal end may be seen in the middle of the torn bulb. In case it is difficult to differentiate, in the mass of torn tissues, a very useful guide is the bleeding from the torn vessels of the bulb. The bleeding point is grasped and drawn out with forceps, and this often reveals the torn end of the urethra. If bleeding has ceased and if the bladder end of the passage has retracted deeply, pressure over the pubes will cause a gush of urine in the wound, thus disclosing the location of the object of search. If the bladder has been aspirated so that pressure can produce no spirt of urine, it is best to content ourselves with having established free drainage. The patient is put to bed for a few hours until urine has accumulated in the bladder and then a second search is made for the urethra, when in all probability it will be readily found. After the two ends have been found they should be united by catgut sutures. Care should be taken to include only the cavernous and muscular tissues in the sutures. After accurate approximation has been secured a catheter should be passed into the bladder and allowed to remain there for about ten days. The external wound should be not sutured, and no drainage is required.

Any injury of the penis which results in solution of continuity of the urethra may give rise to the infiltration of urine. This may result only in a localized abscess or it may be so great as to involve the penis and scrotum very extensively. In the more aggravated cases large areas may slough away, causing death from septic poisoning or such large loss of tissue that the urethra may end at the root of the penis, the whole of the corpus spongiosum and urethra having sloughed. In all cases where urine leaks into the tissues or where such a condition is suspected, the freest drainage is essential if we would avoid extensive necrosis of tissue. If necessary, do not hesitate to divide the scrotum freely down to the corpus spongiosum, leaving the wound open and packing it with gauze in such a manner that one testicle lies on each side. Elaborate plastic operations may later be necessary to restore the urethra or overcome the deformity of the penis. Often it will be impossible to make a new urethra, and the patient may then have to pass the rest of his existence with an opening in the perineum. Bound down, as the proximal end of the urethra is, in a mass of contracting scar tissue, the prospect is anything but pleasing.

Small areas of infiltration may occur from infection of follicles. If neglected, these collections of pus may break into the urethra or externally. If they discharge outside, the sequel is usually a urinary fistula. Curetting and packing with gauze so as to get healing from below up, is the proper treatment.

Strangulation of the Testis from Torsion of the Cord.—The testis may become strangulated from torsion of its cord. This is an uncommon accident. Scudder, in a review of the recorded cases in 1901, was able to find only thirty-two instances. In nearly one-half of the cases the accident occurred in undescended testis; and, in all, the records report some abnormality of the testis. The attachment of the tunica vaginalis has been such that very free movement of the testis within the sac was allowed. In 1904 Edington reported two cases, in one of which the epididymis was wholly within the tunica, the testis hanging suspended from a narrow stalk. The immediate cause of the twist is problematical. There is often a history of strain or excessive coitus, but occasionally no reason for the occurrence can be assigned. The immediate effect of torsion is interference with the blood supply. (See Fig. 477.) The symptoms are sudden severe pain in the testis, often accompanied by nausea, vomiting, or a moderate degree of shock. There may be slight elevation of temperature or even a chill. At times it is extremely difficult to make a diagnosis between a strangulated hernia and the condition described. The constitutional symptoms are less in torsion of the cord than in strangulation of the bowel. There is no obstruction of the bowels, as a rule. If the external ring is empty, the diagnosis is simplified; but, if the condition be associated with a hernia, operation alone can solve the problem.

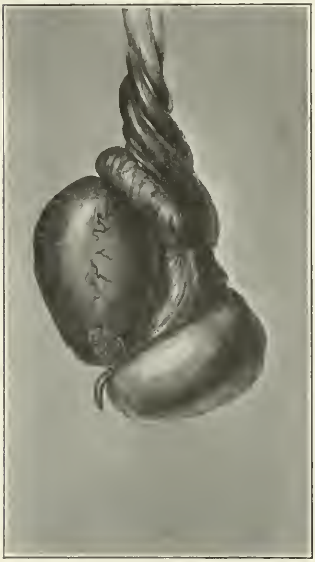

FIG. 477. Twisted Spermatic Cord. (Warren Museum, Harvard Medical School, No. 9846.) Infarction of the testis, which appears enlarged and dark blue.

If the case is seen immediately, an attempt may be made to untwist the cord and save the testis. After two or three hours, however, removal of the testis is called for, as it is sure to become gangrenous or to atrophy. In eighty-eight per cent of the cases reported by Scudder, gangrene of the testis ensued. About seventy-five per cent of the cases occur before the age of twenty-five. There is no mortality.

V. INFECTIONS.

Under this heading will be considered:—(1) Inflammatory processes due to bacterial infection (pyogenic, tuberculous, specific); (2) skin diseases; (3) gangrene; (4) elephantiasis.

Inflammatory Processes.—Inflammatory processes may be set up in any part of the male external genitalia by any of the pathogenic organisms. For convenience, they will be described in three groups, according to the nature of the infecting bacteria.

(*a*) *Pyogenic Infection.*—Pyogenic infection may be due to any of the pyogenic organisms finding a port of entry after trauma, either through the skin, by way of the urethra, or in the blood-stream. According to their site of invasion they produce characteristic lesions, which we now propose to discuss in detail.

Posthitis.—Posthitis is an inflammation of the mucous membrane lining the inner surface of the prepuce.

Balanitis.—Balanitis is a similar inflammation of the mucous membrane covering the glans penis. When these two concur, the condition is termed balano-posthitis. These inflammatory processes of the glans and prepuce commonly occur, from lack of local cleanliness, in patients who have a long, tight prepuce; often as complications of venereal disease; sometimes in connection with diabetes, when the readily decomposing urine forms a favorable culture medium. The immediate treatment consists of cleaning the parts with a mild antiseptic solution, dusting them with calomel, aristol, or other antiseptic powder, and, in cases with phimosis, providing drainage for the preputial sac by means of small strips of gauze tucked under the foreskin. After the acute attack has subsided, or even sooner, in obstinate cases, circumcision should be done to prevent future recurrence of the trouble, and any other contributing cause should be treated and removed if possible. In diabetes, circumcision will relieve but not cure the condition, unless the glycosuria can be controlled by diet.

Superficial infections may extend over the entire penis and scrotum, producing the same forms of cellulitis, erysipelas, furuncle, phlegmon, abscess, lymphangitis, and phlebitis seen elsewhere in the body. These affections may follow trauma with infiltration of urine. They are treated according to general principles of surgery. Abscess of the prepuce occurs particularly in cases of neglected phimosis. In such cases, it may be advisable to incise and drain the abscess first, circumcision being postponed till this wound is granulating or healed, and the field of operation relatively clean.

Cavernitis.—Cavernitis is produced when the deeper parts of the penis are invaded by pyogenic infection. It may lead to suppuration, necrosis, and destruction of the erectile tissues, with subsequent loss of function. Its treatment is free incision and drainage.

Urethritis.—Urethritis is commonly due to gonorrhœal infection, but inflammation of the urethra may be caused by other pyogenic organisms. These conditions and their treatment are discussed at length in a later chapter of this volume.

Epididymitis.—Epididymitis is of frequent occurrence and is usually secondary to an acute urethritis; but it may also occur in connection with a cystitis from unclean instrumentation, or as a true metastasis from a focus of infection elsewhere in the body, or as a complication or sequela of parotitis, pneumonia, typhoid fever, or appendicitis. Whether the infection be derived through the blood-stream or by direct extension downward from the urinary tract, the inflammation may be acute or chronic, unilateral or bilateral, though it is usually limited to one side, more commonly the left.

Orchitis.—Orchitis, or inflammation of the testis, has the same causes and modes of origin as epididymitis, but it occurs much less frequently. Apparently the testis has a higher degree of resistance, for it may often escape infection where the epididymis is involved. Orchitis is always associated with epididymitis.

Acute epididymitis and orchitis are symptomatized by a sense of weight and fulness in the scrotum, with pain extending up the spermatic cord, local swelling, and very acute tenderness. The pain of epididymitis is relieved by supporting the testes, that of orchitis is not. The onset is fairly rapid, with headache, general malaise, elevation of temperature, and increase of sexual excitability. The treatment of these conditions, when due to gonorrhœa, is elsewhere described. When due to simple pyogenic infection, they are usually less severe and obstinate, and are best treated by the combined principles of rest, support, local applications, or counter-irritation (with iodine, silver nitrate, or the familiar but efficient sailor's remedy—a tobacco poultice), by bland, antiseptic diuresis, and by the removal of the cause. Acute epididymitis is sometimes seen as a complication in the convalescence of patients who are subjected to constant bladder drainage after prostatectomy, perineal section for stricture, or cystotomy for calculus or tumor. In such cases the drainage should be removed, at least for a time, since the inflammation will not subside in the presence of the mechanical irritation which favored infection.

Chronic epididymitis and orchitis commonly occur as sequelæ of gonorrhœa, and in old men with enlarged prostate, cystitis, and residual urine, whether they are or are not leading the catheter life. If these affections are intractable and a source of persistent pain and discomfort, orchidectomy and epididymectomy may become desirable, especially in the aged.

Epididymitis and orchitis rarely go on to suppuration; but if they do, incision should be made and drainage established. They generally terminate by resolution, but may be followed by permanent connective-tissue hyperplasia, with greater or less destruction of the glandular, secreting substance, or by atrophy, partial or complete. The orchitis associated with mumps is presumably a metastasis due to the same unknown infective organism as the process in the parotid. At and after puberty it is much more liable to be followed by atrophy than in boyhood. Complete atrophy of both testes of course produces sterility, but this is also and oftener brought about by cicatricial stenosis of the vas and ductuli efferentes following the inflammatory process.

An undescended testis or epididymis is liable to the same infections as if situated in the scrotum. In the abdominal cavity, a secondary peritonitis may develop, which may rarely become general and fatal. Usually the inflammation undergoes resolution with the formation of adhesions. The same is true of the periorchitis occurring in the case of a normally seated testis.

Vesiculitis.—Vesiculitis, or inflammation of the seminal vesicles and of the vas deferens, always occurs in connection with extensions of an infection from the urethra, prostate, or bladder to the epididymis and testis. The process is most commonly of gonorrhœal origin, and its treatment is that of the attendant conditions. Sometimes the pain and fulness in the region of the prostate can be relieved by "milking" the distended vesicles with the finger in the rectum, through which they may be felt enlarged, tender, and indurated. The characteristic symptoms of vesicular infection are pain on defecation and on micturition and erection, which are frequent. There may be blood in the urine, and seminal discharges with the stools.

(*b*) *Tuberculous Infection.*—Tuberculosis is one of the commonest diseases of the genito-urinary organs. The tubercle bacillus may gain access to the tissues of the external genitals either superficially, through the blood, or by descent from the kidney.

Tuberculosis of the penis is of two varieties, both of them rare. (1) Lupus of the penis is a superficial, cutaneous affection like facial lupus vulgaris. It occurs principally in childhood and youth, involves the shaft, prepuce, and glans penis, and produces shallow, diffuse ulcers with irregular, undermined margins. These ulcers progress slowly and heal by obliterative cicatrization. Occasionally characteristic soft, apple-jelly nodules may be seen in the midst of the lesions. The disease is gradually destructive, but may cease spontaneously, as if self-limited. The treatment is the same as for lupus of the face. If the lesion be confined to the foreskin, circumcision may produce complete cure. (2) Cavernous tuberculosis is a deeper infection, involving the erectile bodies in necrosis and sloughing. The treatment is amputation of the penis.

Tuberculosis of the penis was sometimes caused, in infants among Hebrews, by direct infection from the mouth of tuberculous Mohels,* who were in the habit of stanching the bleeding by sucking the organ. In adults it may be similarly caused by practices of sexual perversion.

Tuberculosis of the scrotum is rare, and is likewise of two varieties. (1) Lupus of the scrotum is characterized by circinate lesions. (2) Deep tuberculosis is associated with the formation of fistulæ from sloughing tuberculous orchitis and epididymitis.

Tuberculosis of the urethra is very rare, and is generally secondary to a tuberculous process situated higher up in the genito-urinary tract. It is possible that a primary tuberculous ulceration may develop in the urethral mucous membrane, but such an occurrence is unlikely. The possibility of infection through coitus has never been proved. In the anterior urethra, the lesions are usually situated at the fossa navicularis and in the bulb portion, where the normal dilatation favors urinary stasis. More often the ulcers are in the posterior urethra, near the original source of infection. In any situation, their healing may cause cicatricial stricture. The symptoms are pain, frequency of urination, and occasional hemorrhage on micturition. The diagnosis rests on the determination of other tuberculous lesions, on urethroscopy, and on the finding of tubercle bacilli in the urine. The treatment is the removal of any constant source of infection (as, for example, a tuberculous kidney), the avoidance of instrumentation, the employment of diet, general hygiene, and fresh air, and perhaps inoculations of tuberculin under control of the opsonic index.

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* The name given by the Hebrews to the native doctor who performs the rite of circumcision in conjunction with the Rabbi.

Tuberculosis of the epididymis is very common. There has been much discussion as to whether the disease is primary in the epididymis or secondary to an infection of the prostate or kidney. At present the weight of evidence and opinion seems to be that genito-urinary tuberculosis is generally primary in the epididymis, originating there as a metastasis from a perhaps latent focus elsewhere in the body, not by direct extension. This view is favored by the fact that the disease usually begins in the globus major, where the blood-supply enters, whereas the pyogenic epididymitides begin in the globus minor.

Tuberculous epididymitis is commonest between the ages of twenty and forty, during the period of greatest sexual activity. Trauma and gonorrhœa are predisposing causes. The disease starts on one side, more often the right, but the other side is usually later involved. It begins with the formation of small, hard, painless nodules in the globus major, gradually extending throughout the epididymis. These nodules ultimately undergo caseous degeneration, and break down into abscesses which discharge through sinuses in the scrotum.

Sooner or later tuberculosis of the testis follows tuberculous epididymitis, though the testis always show a higher degree of resistance to the destructive process. The lesions follow the same course of chronic suppuration as they do in the epididymis. (Fig. 478.) The diagnosis of tuberculous epididymo-orchitis involves differentiation from gumma, malignant neoplasm, and actinomycosis. These almost always originate in the testis, whereas tuberculosis typically starts in the epididymis. Gumma has a characteristic stony hardness, is not painful, and does not break down and suppurate early. Malignant tumors grow rapidly, do not break down, and are accompanied by grave constitutional disturbances. Actinomycosis, a very rare disease of the testis, caused by the ray-fungus, actinomyces, may produce a state of chronic induration and suppuration, closely simulating tuberculosis, for which it is commonly mistaken elsewhere in the body. It may be demonstrated by finding the glassy nodules in the discharge, and by an examination of a stained smear. The treatment of actinomycosis is thorough curettage and drainage of the affected parts, and administration of potassium iodide by the mouth.

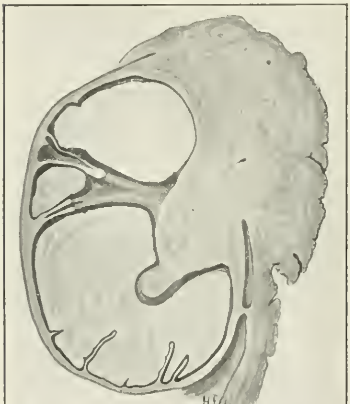


Fig. 478.—Tuberculosis of the Testis. (Warren Museum, Harvard Medical School, No. 2489.) The testis is enlarged and divided into separate compartments by fibrous septa. The compartments or cavities thus formed are filled with yellowish, opaque matter.

Tuberculous epididymo-orchitis, if unchecked, goes on to complete destruction of the organs, though the process may heal spontaneously, as in the case of tuberculosis elsewhere in the body. Radical treatment, with complete removal of the affected parts, was formerly the rule, particularly when the disease was unilateral. The supposition was that this would check the spread of the infection. Experience has shown, however, that this is not the case, since the process usually occurs in a few years on the other side. Recently the wide application of general hygienic measures in the treatment of tuberculosis, and the use of tuberculin as an opsonic vaccine, have opened new possibilities of conservatism. These are now of foremost importance in the treatment of tuberculous epididymo-orchitis, local surgery being reduced to the thorough curetting, and wiping out with iodine, of the sinuses and abscess cavities. Keyes recommends early unilateral epididymectomy, in the belief that, freed from the primary source of disease, the testis will escape or recover from the infection. If it be found later that the other epididymis must be removed, sterility will, of course, follow, though as a matter of fact such patients are usually already sterile

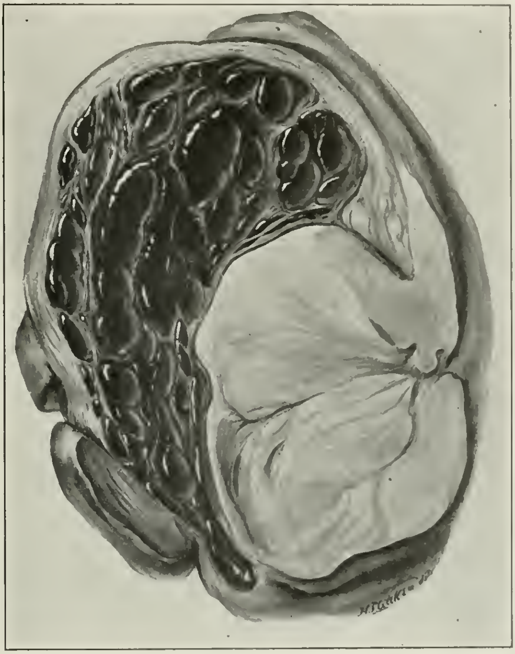


Fig. 479.—Gumma of the Testis; Hæmatocele. (Warren Museum, Harvard Medical School, No. 9688.) The body of the testis has been replaced by a large nodule of cheesy fibrous tissue. The tunica is filled with clotted blood. On the surface is a button-like necrotic area.

at an early stage of the disease. Even bilateral epididymectomy, however, is preferable to castration; for the patient remains potent, though sterile, and retains not only the psychic and cosmetic advantages of his testes, but probably also the value of their internal secretion. Resuturing of the vas should be attempted later in some cases.

Tuberculosis of the vas and seminal vesicles is usually secondary to tuberculous disease elsewhere in the genito-urinary tract. Rarely it may be primary in the vesicle, and may then be treated by removal of the vesicle through an abdominal or a perineal incision. For secondary tuberculous vesiculitis there is no treatment other than that of the primary focus.

(*c*) *Specific Infections.*—The specific venereal infections, gonorrhœa, chancroid, and syphilis, are especially treated in other articles of this book. (See also Fig. 479 and Plate XLVII, Fig. 1.)

Skin Diseases.—Skin diseases of various sorts—inflammatory, parasitic, and neurotic—may affect the penis and scrotum, and occasionally they present in these parts peculiar and characteristic features.

Herpes Progenitalis.—Herpes progenitalis is characterized by the formation of multiple, small, unilocular vesicles on the mucous membrane of the balano-preputial sac, especially in the sulcus behind the corona. The presence of these vesicles is associated with slight burning or itching sensations. Local uncleanliness and a long, tight foreskin are predisposing causes. The vesicles, which are filled with clear, serous fluid, may disappear through absorption of their contents, or they may break and form small, superficial circular ulcers. The treatment is the same as that of balano-posthitis. If the ulceration persists it may usually be checked by the application of silver nitrate. If the lesions recur, circumcision is advisable.

Verruca acuminata, or venereal wart, is a papillomatous hyperplastic growth caused by a heaping up of squamous epithelial cells. The lesions are usually multiple, and may be moist or dry, according to their seat in the balano-preputial sac or on the skin of the penis or scrotum. They may be of various sizes, sessile or pedunculated, ranging in color from pale pink to deep red, and secreting a pungent, viscid fluid. They have been thought to be contagious, and occur in men of unclean habits and much addicted to venery. They may be treated by excision of the wart and cauterization of the base, followed by local cleanliness and the use of an astringent, antiseptic dusting-powder. If for any reason a patient refuse operation, the growth may be treated by painting on it salicylic collodion made up in the proportion of one drachm of salicylic acid to one ounce of collodion. Persistent application of this mixture will generally produce a satisfactory cure, causing even extensive warts to disappear completely.

Other cutaneous diseases which may affect the penis and scrotum are herpes zoster, the various forms of eczema, the several dermatitides, intertrigo and pruritus, psoriasis, favus, leprosy, scabies, pediculi pubis, molluscum contagiosum, pityriasis versicolor, chloasma, and vitiligo. These do not differ from their manifestations elsewhere in the body and they require similar treatment.

Gangrene.—Gangrene may affect separately either the penis or the scrotum.

Gangrene of the Penis.—Gangrene of the penis may occur from a variety of causes. It may follow mechanical or chemical trauma; it may be associated with severe infectious diseases or with the toxæmias of chronic nephritis and diabetes; it may be due to ingested toxins, such as ergot, and to trophic nerve disturbances. In all cases the treatment should be conservative. The penis should be supported by a T-bandage in a position along the abdominal wall, which most favors the circulation. Demarcation of the necrotic portion will always be spontaneously established, and more of the organ will be saved than by surgical intervention. Sexual efficiency is usually preserved.

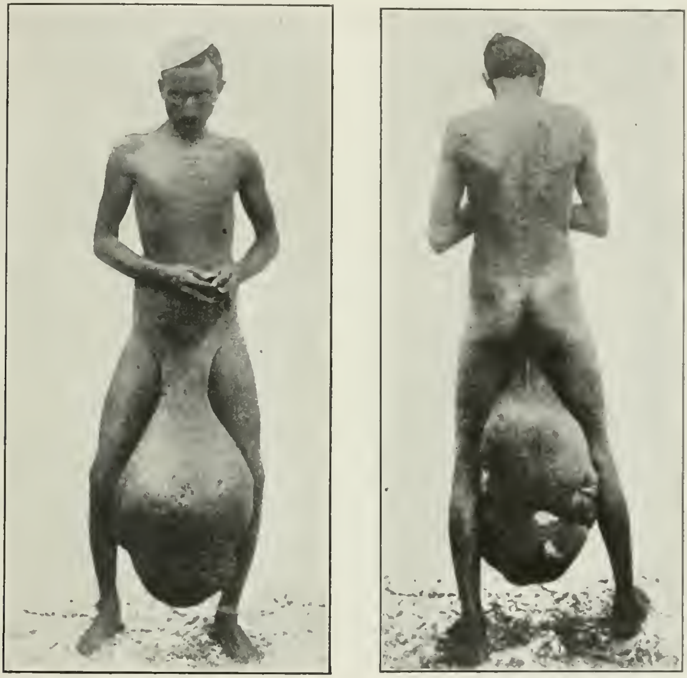


Fig. 480. Fig. 481.

Figs. 480 and 481.—Elephantiasis of the Scrotum. (After Murray.) Fig. 480.—Anterior View. Fig. 481.—Posterior View.

Gangrene of the Scrotum.—Gangrene of the scrotum is due to the same causes as gangrene of the penis and is more frequent. Particular care should be taken to prevent it in patients with infections like small-pox, cholera, and typhoid fever, by supporting the scrotum with a soft dry dressing and suitable bandage, particularly if the scrotum is large and its tissues are lax. When the condition is established it should be treated conservatively with incisions to let out accumulated pus and to permit the cautious removal of necrotic tissue. The process may involve a part or the whole of one or both testes or epididymides, but it usually stops at the tunica vaginalis. In one case under the writer's observation, complete destruction of the scrotum was caused by gangrene following the application of a carbolic-acid poultice for epididymitis. As soon as healthy granulations had formed over the exposed testes, a new scrotum was constructed by means of a large, single Thiersch graft taken from the thigh.

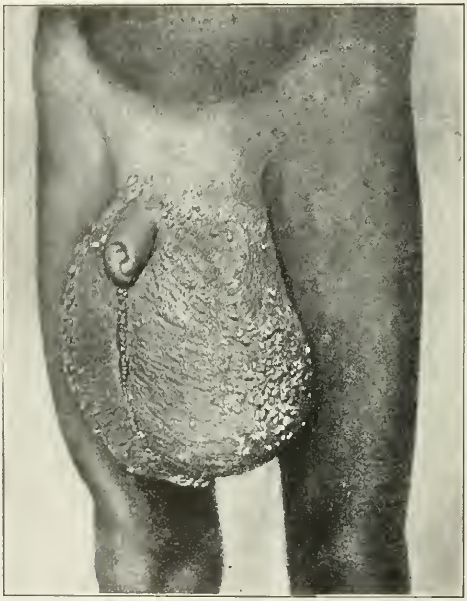


Fig. 482.—Another Case of Elephantiasis of the Scrotum. (After Murray.)

Elephantiasis.—Elephantiasis of the penis and scrotum is rarely seen in this country, though in India and other warm countries it is common. (Figs. 480–483.) It is caused by the Filaria sanguinis hominis and occurs from youth to old age. In a series of one hundred and forty cases, reported by Charles in the *Indian Medical Gazette*, the youngest patient was sixteen, the oldest sixty-two. It may occur with elephantiasis of other parts of the body or alone. There may be numerous complications with it, such as hernia, hydrocele, or varicocele. At operation the spermatic cord may be found of great length or there may be a large amount of blubbery infiltration. The question of operation in any case has to be determined by the amount of inconvenience. There must be no eczema or septic condition of the skin at the time, and very careful preparation for several days is necessary in order to secure an aseptic field of operation. Writers vary as to the advisability of employing a tourniquet. If it is not used, vessels must be picked up at once as fast as they are cut. The first step is the enucleation of the penis. It must be constantly borne in mind that all tissues drained by the inguinal lymphatics must be removed. The lithotomy position is used. The first incision is from over the pubes down to the preputial opening. This incision is carried around the opening and the penis enucleated by blunt dissection down to its attachment to the pubes. Care is necessary to avoid injury to the dorsal vein. The next incision starts at the external abdominal ring and curves around the neck of the tumor down toward the median line in front of the anus. This cut is repeated on the opposite side. The testes are now enucleated by blunt dissection and the penis, testes, and cord are held up over the pubes while the base of the first incision is joined to the starting point of the side incision and the whole mass cut away. Great care must be taken not to injure the urethra which is often much distorted by traction of the tumor. The skin flaps are next freed on each side sufficiently to allow them to be brought together in the median line. The testes are tucked under these flaps. Where these skin flaps encircle the penis they are stitched to it by sutures which pass through the tunica albuginea. The prepuce should be wholly cut away and

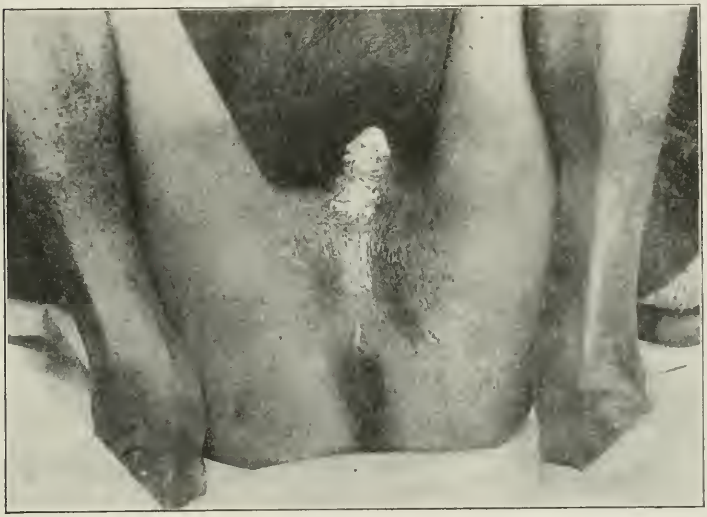


Fig. 483.—Elephantiasis of the Scrotum. Condition of the parts after operation. (Same case as that shown in Fig. 482.)

skin grafts applied over the entire body of the penis. The dressings in the perineum are held in place by a figure-of-8 bandage. Drainage should be provided at the lower end of the incision. Recovery takes place rapidly and healing usually occurs by first intention. A period of twenty-one days represents the usual stay in the hospital. In 1901 Charles reported one hundred and forty consecutive cases without a death, and Maitland had operated on one hundred and twenty-five cases with two deaths. One death was from diabetes mellitus and the other (in the case of a very feeble old man) was from sepsis. In one instance the tumor weighed one hundred and ten pounds. The after-results are excellent. The position of the testes is awkward at first, but a scrotum forms in time and the penis is perfectly useful.

VI. TUMORS.

Under the heading of tumors may be classed (1) swellings which are neither inflammatory nor neoplastic, and (2) neoplasms (benign or malignant).

(1) **Swellings which are Neither Inflammatory nor Neoplastic.**—Under this heading are included:—Varicose conditions, œdema, emphysema, hydrocele, spermatocele, and hæmatocele.

(*a*) *Varicose Conditions.*—Varicose veins of the penis and scrotum are not common, and occur usually in patients with relaxed tissues and a tendency to varicosis elsewhere. They are generally associated with varicocele. They may cause a sense of fulness, weight, and dragging pain in the parts, but produce no harm unless they are excessively developed. Palliative treatment by cold-water douches and by improvement of the general systemic tone may be beneficial. Surgical treatment consists of excision and multiple ligation of the knotted, swollen venous plexus.

Varicocele is a varicose condition of the pampiniform plexus of veins in the spermatic cord. Occasionally the veins of the testes may also become involved. The condition is almost invariably on the left side, the right being very rarely affected. An anatomical reason for this is that the left spermatic vein enters the left renal vein at a right angle, whereas the right spermatic vein enters the inferior vena cava at an acute angle. There is, therefore, a higher column of blood and less freedom of outflow in the spermatic vein on the left. Another reason has been thought to be pressure on the left spermatic vein by a chronically distended sigmoid. Varicocele may similarly be a pressure-symptom of an abdominal tumor or of an improperly fitting truss.

Varicocele usually makes its appearance in young men of from eighteen to twenty-five years. To a greater or less degree enlargement of the veins of the cord exists in every adult male, but it is of importance only when it produces symptoms. Even these, in a majority of cases, are subjective and due to the imagination of the patient, who fancies all sorts of direful consequences of his ailment. Quack advertisements about the "deadly varicocele" excite him sometimes to a state of almost frenzied apprehension, which requires the physician's greatest sympathy and patience to allay. Sometimes, on the other hand, there may be no symptoms directly referable to the varicocele, and a patient may be wholly unconscious of any abnormality until an examination for the army or navy, or for the fire or police service, brings out the knowledge that he is suffering from a condition which bars him from such service. More often, however, there is a slight dragging sensation, running up along the cord and into the back, or a sense of weight in the testis. Exertion may increase these sensations. Exceptionally there may be actual pain, especially after long exercise in the erect position. On lying down, the pain disappears.

The diagnosis of varicocele is usually easy. The left side of the scrotum is felt to contain a mass of knotty, twisted cords lying between the testis and the external ring; and in very rare cases the same sensation is felt on the right side of the scrotum. When the patient stands, this mass presents the characteristic appearance, and conveys to the examiner's sense of touch the impression of a bunch of angle-worms; when he lies down, the mass in large measure subsides, but the empty, thickened veins can usually be felt. When the patient coughs the mass may convey to the examiner's fingers a sensation very similar to the impulse conveyed under the same circumstance by a hernial mass. This is due to the blood being forced into the large veins by the increased abdominal pressure. The possible presence of a complicating hernia can be determined by having the patient cough while lying down. The sensation conveyed by the mass of veins in varicocele readily differentiates it from hydrocele or spermatocele.

The prognosis of varicocele is good. Apart from the discomfort experienced in certain cases, there is little disability. Rarely there is some atrophy of the testis on the affected side, both directly from pressure of the mass, and indirectly from interference with its blood supply.

Indications for surgical treatment of varicocele are not very common. Operation is generally unnecessary, and should not be resorted to until other measures have been tried. Medical treatment aims at promoting the circulation in the dilated veins. All causes of active or passive congestion of the testis, such as long walks, horseback riding, long periods of standing, bicycling, dancing, excessive venery, and constipation should be avoided. Cold applications to the scrotum and perineum, morning and night, are advisable, since they tend to promote contraction of the scrotal muscle fibres. The cold perineal jet douche may also be found of value. A suspensory bandage should be worn by day, and, if properly fitted, it should not be uncomfortable. In hot weather it should be frequently changed and washed, or it may chafe and irritate the scrotum. Such treatment, accompanied by moral suasion to remove the patient's fears, will generally relieve the symptoms, or at least keep the condition stationary. Only when the symptoms tend to recur, should radical cure by operation be attempted.

Operations.—Various operations for varicocele have been devised and used,—such, for example, as tight compression, galvano-puncture, resection of a portion of the scrotum, and subcutaneous ligation of the veins,—but all have given place to ligation of the veins after open incision. The cut may be made anywhere between the testis and the external inguinal ring, but is best made just below the ring. The cord and testis are readily drawn up, and the high position of the incision makes the operative field easier to sterilize and to keep clean. The veins are carefully isolated from the vas and the spermatic artery, then ligated in two places, from one to three inches apart, and the portion between the ligatures is cut away. One or two veins should be left for normal blood return. The ends of the ligatures should be left long, so that they may be tied together, thus approximating the cut ends of the veins and forming a cord to support the testis without undue strain on the artery and vas. Great care must be taken to secure complete hæmostasis, for small bleeding points may later give rise to a troublesome hæmatoma. A dressing should be applied and held in place by collodion, since bandages are prone to slip out of position as the patient moves. The cure should be complete in about ten days, though a lump, and occasionally tenderness, may persist for some time longer. A well-fitting suspensory bandage should be worn for at least six weeks. Complications are infrequent, but atrophy or even sloughing of the testis has been reported. For this reason, before any operation is performed, the testis should be carefully examined, and, if any atrophy be already present, the patient's attention should be called to it, without alarming him, so that he may not later accuse the surgeon of having caused it.

(*b*) *Œdema of the Penis and Scrotum.*—Œdema of the penis and scrotum may occur as one of the manifestations of a general anasarca, whether of cardiac, renal, or hepatic origin; it may also be due to local interference with the venous or lymphatic drainage of the genitals from pressure by an enlarged prostate or by a cancer of the rectum or some other form of pelvic tumor, or it may occur in connection with gonorrhœa, or after circumcision. In the former case, the treatment is that of the general condition; in the latter, the attempt should be made to remove the cause, if possible.

(*c*) *Emphysema of the Penis and Scrotum.*—Emphysema of the penis and scrotum may occur as part of a general emphysema following thoracic injury with perforation of the lung. Rarely, it may be due to local trauma, as from a trocar wound which admits air to the tissues. Pneumatocele may also be due to infection with gas-producing bacilli, especially the Bacillus aërogenes capsulatus of Welch. Such forms require, as elsewhere, immediate incision and free drainage, or even radical amputation or castration. Traumatic, non-infective emphysema disappears spontaneously by absorption of the air into the blood.

(*d*) *Hydrocele.*—The processus vaginalis of the peritoneum may never become shut off from the general peritoneal cavity after the descent of the testis. This gives rise to what is known as a congenital hydrocele. Again, the neck of the sac may be obliterated, but fluid may collect in the sac so that it becomes distended. This condition is known as a hydrocele. Rarely, the processus may be obliterated at two or more spots, thus forming multiple hydrocele along the cord, with perhaps a larger one surrounding the testis.

A hydrocele may be unilateral or bilateral, acute or chronic.

Acute Hydrocele.—Hanging freely as the testis does, it is much exposed to trauma. On the other hand, it moves freely out of the way and except in severe injuries is not often injured to such an extent that a hydrocele develops. Traumatic hydrocele may result from a kick, from being thrown against the pommel of the saddle, or from any violence which carries the testis as far as its mobility will allow and crushes it against the leg or pubic bone. The commonest cause of this condition is an inflammation of the epididymis or testis. This is usually of gonorrhœal origin and may be extremely painful. Agonizing as the pain may be with the organ in its normal position, it is doubly hard to bear when the testis is only partly descended, as the organ, from its contracted quarters in the canal, has then no opportunity to expand. Roughness in the manipulations incident to the reduction of a hernia may produce an acute hydrocele. Tapping a chronic hydrocele or the injection of any irritating fluid into its sac may convert a chronic into an acute process.

Chronic Hydrocele. — Chronic hydrocele (Fig. 484) may arise from the acute form when reabsorption of the fluid has failed to take place, but usually its origin is obscure and its growth slow. Congestion due to some obstruction to the return flow of blood is a usual cause. It is often present in syphilis of the testis or epididymis and is commonly seen in tuberculosis. A double hydrocele is usually dependent upon one of these two causes. A hernia or a truss may furnish the cause of obstruction to the return circulation, as may also disease of the liver or kidneys. It is not often seen in general dropsy. It is a condition frequently seen in connection with elephantiasis and is commonly associated with malignant disease of the testis or the epididymis.

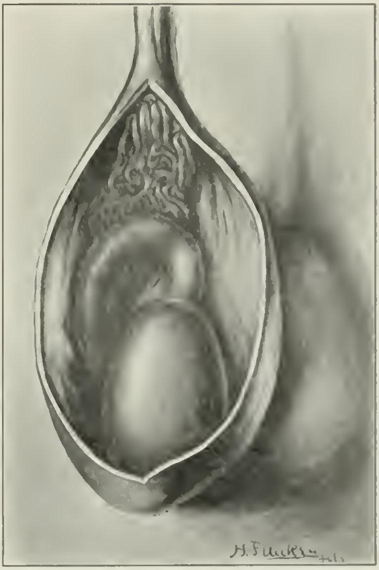


Fig. 484.—Hydrocele. (Warren Museum, Harvard Medical School, No. 9683.) The testis is surrounded by the sac, which has a thickened wall. The epididymis is well marked, and in the upper part of the sac the pampiniform plexus of veins is visible.

Symptoms.—There may be few or no symptoms. The onset of the chronic form is insidious, and a patient's attention is first attracted by the increasing size. The only pain is from the dragging weight. As the tumor becomes very large the testis is compressed (Figs. 485 and 486) and this may give rise to some neuralgic pains. When it has assumed enormous proportions the penis may be drawn back to such an extent that there is left only a slit in the skin where the urine issues. In the early stages of its development, it will be noticed that the swelling lies in front of the testis. In a large hydrocele the testis may or may not be made out on the back of the tumor.

Diagnosis.—A hydrocele may be confused with a hernia, a new-growth, a hydrocele of the cord, a spermatocele, or an hæmatocele. The diagnosis between a hernia and a hydrocele may be of the utmost importance. A hernia may be tympanitic, a hydrocele is never so. Hernia is not translucent, a hydrocele usually transmits light. It is only the old cases, with thickened walls or with darkened contents from blood coloring matter, that do not transmit light. A hernia may be capable of reduction. A hydrocele gives no impulse on coughing except in congenital cases, whereas hernia usually gives an impulse. A distended large hydrocele may give a transmitted abdominal impulse on coughing. Finally, in a hydrocele the tumor remains when a finger is introduced into the ring and the inguinal canal is proved empty. A hernia and a hydrocele may exist at the same time. In determining whether we have a new-growth or a hydrocele to deal with, the shape of the tumor is often of great help. A hydrocele is usually smooth and pear-shaped. A new-growth is generally irregular. A hydrocele is not tender on pressure, whereas a new-growth is. Except in the case of a cystic testis a new-growth is not translucent. In some instances a sense of fluctuation can be detected when fluid is present, but in others the hydrocele is so tense that it cannot be distinguished from a solid growth. In these cases tapping with a fine needle gives information of the greatest value. In this way only can spermatocele and hæmatocele be proven, though we may at times be quite positive of a spermatocele from its position behind, instead of in front of, the testis.

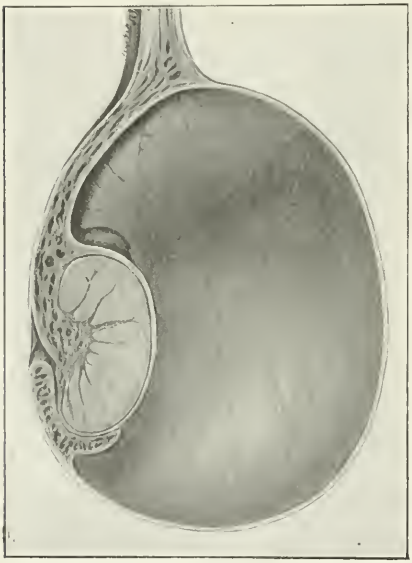


Fig. 485.—Hydrocele. Sac in front of the testis.

Prognosis.—Spontaneous cure in adults is extremely rare, though not uncommon in small children. As a rule, the tumor gradually increases in size until it attains such proportions that it may reach almost down to the knee. These large growths, from their constant dragging, are apt to cause hernia. They are constantly wet at each micturition, and as a result they become eczematous and frequently slough superficially until they present an unsightly appearance and are a source of great inconvenience, pain, and danger to their unhappy possessors. At times there is a loss of the spermatic function of the testis.

Treatment.—Treatment may be palliative or it may be conducted with a view to a permanent cure. A hydrocele rarely remains stationary. There may be times when for months there is no appreciable increase in size, but, as a rule, the tendency is constantly to grow larger. At first, a large suspensory bandage may be all that is required. Later, tapping at longer or shorter intervals will be necessary. Patients who are unwilling to give up the requisite time or are timid about operation, have gone comfortably for years with an occasional tapping. The frequency with which the fluid has to be drawn off varies. Sometimes twice a year will be sufficient to keep the tumor down to reasonable proportions. Again, once a month may prove ineffectual.

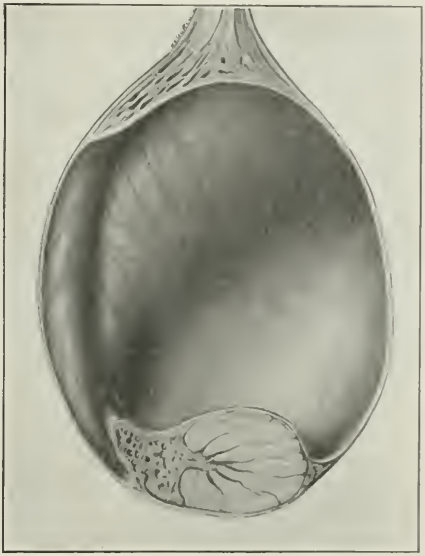


FIG. 186.—Hydrocele. Sac above the testis.

Operations.—The least formidable operation which promises permanent relief is the injection method. The fluid of the hydrocele is first withdrawn and then a small amount of some irritating fluid, such as tincture of iodine or strong carbolic acid, is injected into the sac. This sets up an inflammation which causes the two surfaces of the tunica vaginalis to become adherent to each other, thus obliterating the cavity. Iodine and carbolic acid are about equally certain, each giving about eighty per cent of cures in properly selected cases. These remedies should not be used in very large collections of fluid, nor in old hydroceles which have been tapped repeatedly and have thickened or even calcareous walls, nor in those which are dependent on uncertain causes. Iodine is far more painful than carbolic acid and the reaction is more severe. If iodine is used, the quantity injected should equal about one-eighth of the fluid removed. If carbolic acid is employed, it will be sufficient to inject from 15 to 20 minims of the liquefied crystals. Care should be taken to remove all the hydrocele fluid possible, as the injected fluid coagulates what is left.

We have known neglect of this precaution to be followed by a reaction so severe as to necessitate a secondary operation for the evacuation of the coagulated fibrin. As the fluid is being withdrawn from the sac the cannula may escape from the cavity and lie with its end between the skin and the outer layer of the tunica. If the iodine or carbolic acid is injected while the cannula is lying in this faulty position, severe sloughing may follow. If, before the trocar is plunged in, a small area on the sterilized skin is covered with sterile vaseline and if the trocar is inserted through the middle of this area, not only will the instrument enter more easily, but the skin will be protected from the occurrence of a carbolic-acid burn when the cannula is withdrawn. It is perhaps needless to add that the spot for the puncture must be carefully selected with a view to the avoidance of veins and also with regard to the possible injury of the testis itself. If a vein is cut and a hæmatocele results, open incision should follow at once and the blood clot should be evacuated. With very nervous patients a small area may be frozen with ethyl chloride before the trocar is inserted. The injection of cocaine is about as painful as is the insertion of the trocar. The injection of the carbolic acid gives very slight momentary pain. The patient should remain in bed for from two to four days, according to the amount of reaction. Two days usually suffice if carbolic acid is used. A suspensory bandage should be worn for from two weeks to a month.

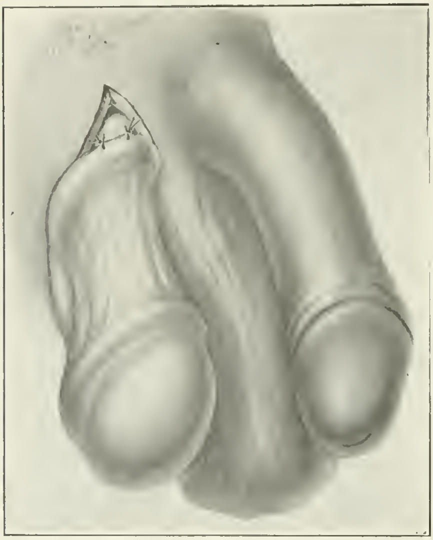


FIG. 487.—Jaboulay's Operation for Hydrocele. (After Hartmann.) Parietal portion of the sac has been dissected out, and all of the sac wall has been excised except a portion just large enough to cover the cord. In the drawing the everted sac is shown to be wrapped around the cord and epididymis and to have been sewed to these structures at a point close to the opening in the skin.

In very large hydroceles; in those of congenital origin and in those with thick sacs; in cases where it is desirable to examine the testis more closely; in cases also where a positive cure is desired, and in all hæmatoceles, the open incision is the operation of choice.

A short incision is made through the skin, underlying tissues, and tunica, and the fluid is evacuated. The testis is then examined and, if there is nothing to make its removal necessary, we have a choice of several methods of disposing of the sac. We may dissect it back to its reflection from the testis, epididymis, and cord, removing the whole of the parietal portions; or we may, after the method of Volkmann, stitch the cut edge of the tunica to the skin and then approximate the two layers of the tunica by interrupted sutures passed through the skin. A drain should be inserted at the lower angle of the wound. Perhaps the simplest method is that of Jaboulay. (Fig. 487.) He opens the tunica by a short incision and then turns the testes out through the hole. The edges of the tunica are then caught together by a stitch behind the cord. This turns the sac completely inside out, thereby bringing the secreting surfaces against a connective-tissue layer. It has the advantages that it can be done through a short high incision, that local anæsthesia, or at most a very short general anæsthesia, is sufficient, and that the wound can be closed tightly. In all cutting operations about the scrotum great care should be taken to secure absolute hæmostasis. A very small vessel gives a large hæmatoma in the loose tissues of these parts.

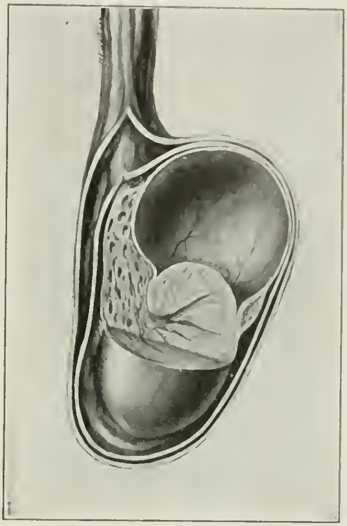


FIG. 488.—Spermatocele. In contrast to hydrocele the distended sac, filled with semen, is placed, as is usual in these cases, above the testis. Section reveals a normal testis.

(*e*) *Spermatocele.*—A spermatocele (Fig. 488) originates either from a simple serous cyst, which, starting outside the seminiferous tubules, afterward establishes a communication with the tubules containing the spermatozoa, or from a cyst which has its starting point in an injury of the seminal tubules and thus contains spermatozoa. To the latter class belong the spermatoceles of traumatic origin and retention cysts produced from any stenosis of the ducts. These are most commonly seen at the head of the epididymis. They are usually outside the tunica vaginalis, but may be found inside. Cases are recorded where, in tapping a hydrocele, two distinct fluids were obtained. The trocar went through a hydrocele to tap a spermatocele nearer the testis. Again, a spermatocele may rupture into a hydrocele, thus accounting for the occasional presence of spermatozoa in the fluid of a hydrocele. There may be more than one cyst or there may be a spermatocele behind the testis and a hydrocele in front.

These cysts vary much in size. They are commonly smaller than hydroceles and contain from a few drachms to a few ounces of fluid. They may attain considerable size.

The fluid differs both in appearance and chemically from that found in hydrocele. It has been variously likened to barley water and milk and water.

It is usually somewhat opalescent. Under the microscope enormous numbers of spermatozoa and a few cells are seen. The spermatozoa are generally motile. Chemically, very little albumin is found and the specific gravity is very low.

Symptoms.—There are seldom any symptoms connected with a spermatocele. The patient discovers the condition by accident and, except in the larger spermatoceles, which may cause great inconvenience, the tumor gives no discomfort. Very rarely there may be some pain or a dragging sensation.

Diagnosis.—These cysts are at times extremely hard to diagnosticate. If they are very small they may be mistaken for inflammatory swellings from gonorrhœa or other infection. The testis is below and in front of the swelling in spermatocele, whereas the reverse condition holds with hydrocele. The fluid may be under such tension that the sense of touch alone cannot distinguish a solid from a fluid. Spermatoceles are generally very thin-walled and light is transmitted in consequence rather more freely than in hydroceles. Hæmatocele and chylocele transmit light much less freely or not at all. A final resort must be made, in doubtful cases, to tapping with a subcutaneous-syringe needle.

Treatment.—In a certain proportion of cases a cure is effected by tapping alone. The injection of from ten to fifteen minins of liquefied carbolic acid crystals after the fluid has been withdrawn, makes the chance of a cure much greater. Tincture of iodine may be used instead of the carbolic acid, but it is much more painful and no more certain in the results which it produces. Finally, the cyst may be dissected out. This is easily done, but, as in all operations on the scrotum, accurate hæmostasis is necessary to insure against hæmatoma.

(*f*) *Hæmatocele.*—Hæmatocele is an accumulation of blood in the sac of the tunica vaginalis. Its advent is sudden and is usually associated with trauma. It may occur after operations for hernia and hydrocele, or after tapping a hydrocele, from injury to a small vessel with the trocar. It may be dependent on a highly vascular new-growth. Hæmatocele does not transmit light with the hydroscope. The treatment is incision, evacuation of the clot, ligation of the bleeding point if there be one, irrigation, and drainage. Infection of hæmatocele or a hydrocele may produce the condition known as pyocele—an accumulation of pus in the sac of the tunica vaginalis. When its development is secondary to a tuberculous epididymitis, the onset is slow.

The treatment is incision, curettage, and drainage. The rare condition of chylocele represents a collection of chylous fluid in the tunica vaginalis, caused by filarial infection of the lacteals and lymphatics.

(2) **Neoplasms.**—Under this heading are included the remaining tumors of the male external genitals, whether strictly neoplastic or not. They may be benign or malignant.

(*a*) Tumors of the Penis.—With the exception of cancer, tumors of the penis are rare.

Lipoma.—Lipoma is very rare, but may occur subcutaneously as in any other part of the body.

Fibroma.—Fibroma is rare, and is generally connected with the corpora cavernosa.

The treatment of both these tumors is enucleation.

Angioma.—Angioma may be capillary or arterial. The capillary angioma is the common naevus, while the arterial variety is an erectile pulsating tumor filled with blood-spaces. If the tumor is small, it may be excised; if it is large, the better plan is to treat it by electrolysis, by multiple puncture with the thermo- or galvano-cautery, or by the use of liquid air. Lymphangioma may also occur, especially on the prepuce. It should be treated in the same manner as the other forms of angioma.

Sebaceous Cysts.—Sebaceous cysts may occur in any part of the penis where sebaceous glands exist. Their treatment is the same as that of wens in other parts of the body.

Dermoid Cysts.—Dermoid cysts have been described under the head of malformations.

Papilloma.—Papillomata (Fig. 489) may occur on any part of the penis, particularly in the sulcus behind the corona glandis. Such papillary growths represent a benign heaping up of squamous epithelium. Their treatment is excision, followed by cauterization of the base with silver nitrate.

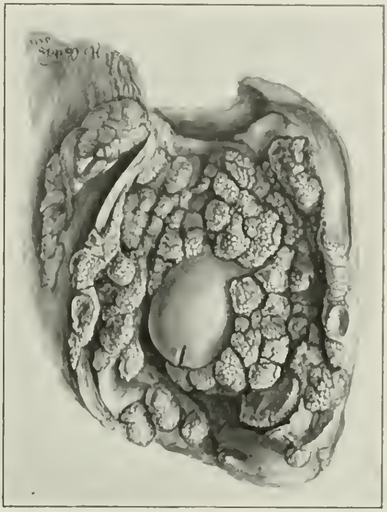


Fig. 489.—Papilloma of the Penis. (Warren Museum, Harvard Medical School, No. 5705.) Extensive, fine warty outgrowths on the inside of the prepuce, which appear on the outer surface through fistulous openings. The patient, a young negro, had complete phimosis, and severe hemorrhages occurred from the diseased area.

Cutaneous Horns.—Cutaneous horns, analogous to those found in other parts of the body, sometimes grow at the root of the penis or behind the corona. They may be single or multiple, and may attain considerable size, forming an obstacle to coitus. They represent a morbid development of the stratum corneum of the epidermis. Roy reports several remarkable cases. The treatment is excision; but the growth has a tendency to recur unless the entire matrix is removed.

Chondroma.—Chondroma is a rare tumor of the penis. It is usually connected with the corpora cavernosa.

Osteoma.—Osteoma may appear in the penis, not as a true tumor of bone, but as an ossification or calcification of the erectile organs. Possibly it represents an abortive reversion to the os penis or os priapi of certain animals; but, since it commonly follows trauma, it seems more likely that it is analogous to the muscular ossification sometimes seen at the site of blows. The treatment is excision; but, if the growth produces no symptoms, it may be left, since removal is sometimes accompanied by severe hemorrhage.

Condyloma.—Condyloma occurs as a papillary outgrowth upon the glans and the foreskin. It is caused by a growth of the papillary layer of the skin and is associated with enlargement and new-formation of the blood-vessels themselves. The condylomata may spread over the surface of the glans and inner aspect of the foreskin until a conglomerate irregular mass results, which resembles carcinoma. It differs from carcinoma, however, in the fact that it has a soft, non-infiltrated base. The separate papillary projections which constitute the mass may be removed with scissors, and afterward the base should be cauterized with a cautery or with strong nitric acid. Salicylic collodion may rarely cause absorption of the growth without operation.

Sarcoma.—Englisch states that sarcoma occurs in only 4.2 per cent of all malignant tumors of the penis. Its structure varies in character according to the degree of involvement of the cavernous spaces. In comparison with sarcomatous tumors in general, epithelioma occurs in the penis with relative frequency. Tripke describes a case where an oval tumor was found placed at the beginning of the corpora cavernosa. The involvement of the vessels reduced the anterior part of the penis to a narrow cord, shiny and dark-colored. Microscopic examination showed the tumor to have an alveolar structure, the spaces being filled with round cells which seemed to have originated from the endothelial lining of the blood spaces. Other cases of this sort have been reported by Hildebrand, Colmers, and others, in some of which the alveolar arrangement was not found, though the cells apparently originated from the endothelium of the blood-spaces. The so-called true sarcoma usually takes its origin from the intervascular connective tissue of the erectile bodies. Melanosarcoma of the penis (Fig. 490) is rarely seen. It has no relation with the blood spaces, but starts from a nævus, or from a markedly pigmented spot. Keyes reports a case in which such a tumor developed primarily in the frenum glandis. From it metastatic foci developed in the mucous membrane of the urethra and in the upper surface of the glans. A specimen of this sort is preserved in the Warren Museum at the Harvard Medical School.

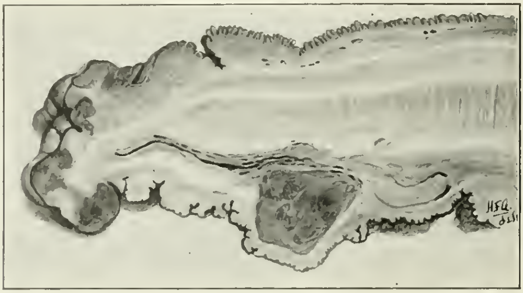


FIG. 490.—Section of a Melanotic Sarcoma of the Penis. (Warren Museum, Harvard Medical School, No. 9596.) New-growth involving the glans and extending backward along the urethra; several large nodules.

Carcinoma of the Penis and Foreskin.—Carcinoma of these parts (Fig. 491) appears in men between the ages of thirty and forty. It is usually of the squamous-cell type. This variety does not form metastases at an early stage, and is relatively not malignant. The papillary variety develops with rapidity. It is characterized by irregular projecting masses, the bases of which are placed near the corona glandis. Palpation of the base of the growth discovers a hard resistance which points to infiltration into the tissue beneath. Cancer of the penis in its later stages frequently breaks down and forms ulcers. Occasionally the ulcer is found to be associated with a small warty growth, or it develops after this has existed for a certain length of time. The corpora cavernosa are rarely attacked at first, but may be involved when the growth has infiltrated deeply from without inward. As a rule, the inguinal lymph nodes are the only ones infected; further metastases are rare. It will be remembered that the lymphatics of the penis are arranged in two systems—a superficial and a deep. Both intercommunicate freely about the corona glandis and carry lymph from the skin and deeper parts to the inguinal lymph nodes by means of the superficial and deep dorsal channels. These collecting trunks may be single or double, and communicate with each other with more or less freedom. The dorsal lymphatics of the penis are infected early in cancer of the penis, while the corpora cavernosa, as mentioned before, are only secondarily invaded. When the disease has extended into the deeper portions of the cavernosa and the corpus spongiosum the metastases are carried under the pubic arch into the pelvic lymph nodes. Such an infiltration demands complete removal of

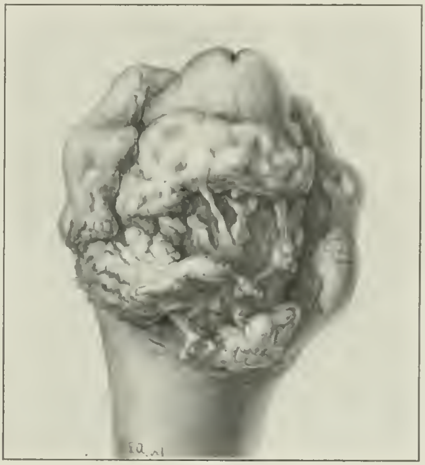


FIG. 491.—Epithelioma of the Penis. (Warren Museum, Harvard Medical School, No. 2900.) A fungous, ulcerating new-growth which has invaded the glans and the prepuce.

the penis with its crura. The immediate results of the operation may be encouraging, but it is not often successful in preventing a recurrence.

Amputation of the Penis.

Cancer of the penis may be said to be operable when the disease is limited to the distal third of the organ. There may, in these cases, be infection of the superficial inguinal lymph nodes through the dorsal lymphatics, but the infection has not yet reached the infrapubic lymphatics. The success of the attempted removal of the disease rests upon the thoroughness with which the infected lymphatics and lymph nodes are dissected out. The anterior two-thirds of the penis must be sacrificed in nearly all cases. Nicoll removes the dorsal vessels and lymphatics, their surrounding connective tissue and fat,

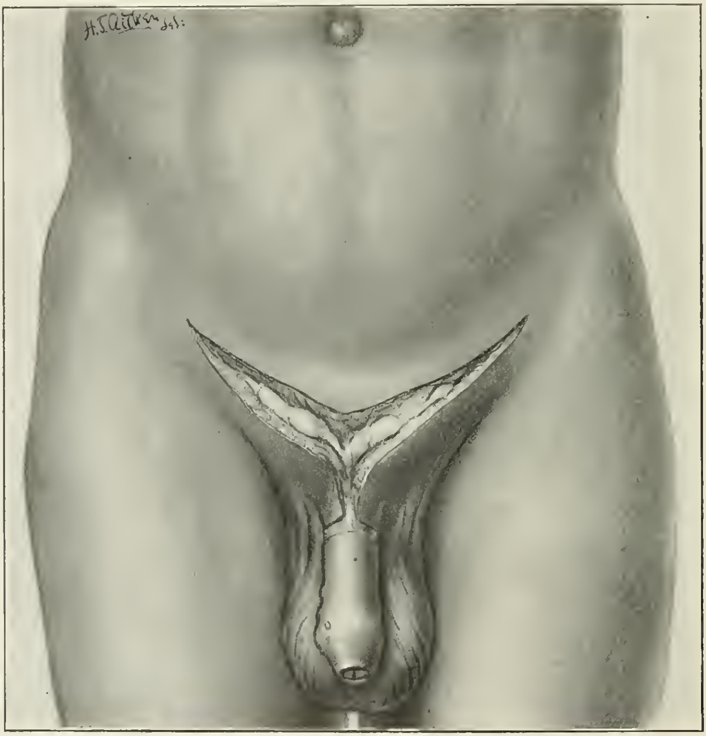


Fig. 492.—Partial Amputation of the Penis; Nicoll's Operation; First Step. Y-O incision. The O loop circles the penis obliquely and extends only through the thickness of the skin. The dissection of the dorsal lymphatics is carried up into the groin.

together with the inguinal lymph nodes, through one Y-shaped incision. Further indications to be fulfilled in carrying out amputation of the penis are the control of hemorrhage and the prevention of secondary contraction of the meatus.

Amputation may be either partial or total.

Partial amputation of the penis may be done by the following steps (Nicoll):—Sound passed into bladder; Y-incision on dorsum, oblique circular incision of the body of the penis; lymph nodes of groin dissected out; lymph nodes about external iliac vessels dissected out; excision of dorsal blood and lymphatic vessels; amputation of cavernous bodies, and, next, of spongy body; transverse splitting of the urethra for suture purposes; suture. A sound is passed into the bladder, and the handle is depressed between the thighs. The Y-incision is made, as shown in Fig. 492. The arms of the Y extend along the folds of the groins, their common continuation is carried down over the dorsum of the penis for a distance approximately equal to one-third or one-fourth of the proximal portion of the penis. This terminates in a loop which obliquely encircles the penis. The portions of the incision which traverse the dorsum and groin are deep, but the circular cut around the penis merely passes through the skin. (Fig. 493.)

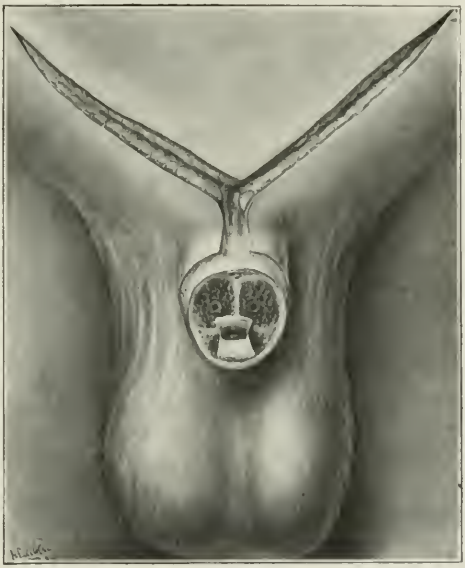


FIG. 493. Partial Amputation of the Penis; Nicoll's Operation; Second Step. The penis has been removed, the urethra being left longer than the corpora cavernosa; the urethra is split transversely.

The lymph nodes, with their bed of fat, are cleanly dissected from both groins, and ligatures are applied to the superficial epigastric, the superficial circumflex iliac, and the external pudic arteries and veins. The femoral sheath is then exposed, through the fascia lata, and the peritoneum is pushed back in order that the fat which lies about the external iliac vessels may be explored for infected lymph nodes. All infected tissue is freely removed from this situation. The dorsal blood and lymphatic vessels are taken out cleanly down to the sheaths of the corpora cavernosa, the dorsal vessels being tied off close to the suspensory ligament.

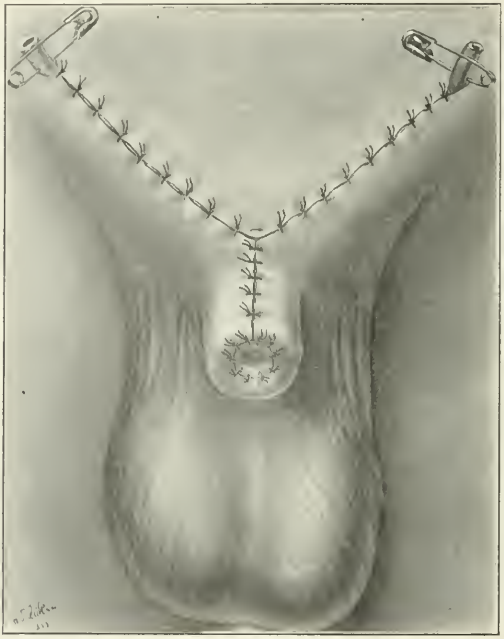


Fig. 494.—Partial Amputation of the Penis; Nicoll's Operation; Third Step. Suture of wounds. Drainage of groins for lymphorrhœa.

The knife is passed between the corpus spongiosum and the corpora cavernosa at the level of the skin incision, and the cavernous bodies are divided. The sound is now removed and the corpus spongiosum is amputated at a point somewhat anterior to the line of division of the corpora cavernosa, thus leaving the urethra projecting beyond the corpora cavernosa, its inferior lip longer than the superior. The urethra and corpus spongiosum are now slit transversely for a distance of about one-third of an inch on each side.

Hemorrhage is controlled during the operation by tying the arteries which supply the corpora cavernosa and the corpus spongiosum. The posterior incision makes the use of a tourniquet impossible, and the vessels are seized as soon as the cavernous bodies are dissected. The vessels are best clamped together with the surrounding tissue, and thus tied. The friability of the erectile tissue may lead to failure of an attempt to isolate the vessels before tying.

The wound is closed with interrupted sutures. (Fig. 494.) The oblique direction of the skin incision encircling the penis, the projection of the spongy body, with the oblique section of the urethra, all combine to form a spout-like inferior lip for the meatus.

Nicoll advises drainage of the inguinal incision for a time to give vent to the collected lymph. No permanent bladder drainage is employed, but the patient is catheterized periodically, for three or four days, after which he is allowed to pass urine.

A double spica bandage with pressure is used to cause obliteration of dead spaces resulting from the dissection of the inguinal region, and over the penis a light dressing is applied.

Partial Amputation of the Penis by the Flap Method.—In cases where there is no enlargement of the lymphatics or of their attached nodes, when the disease is very circumscribed, the dissection of the lymphatics is usually omitted. This permits the use of the tourniquet, and the following are then the steps of the operation.—Tourniquet; large anterior convex flap; short posterior flap; reflection of flaps, and amputation of cavernous bodies; amputation of urethra, leaving excess of tissue for suture; application of the sutures. Upon the dorsal surface of the penis there is marked out a large convex flap, which points toward the glans and the width of which corresponds to the transverse diameter of the penis. Upon the lower surface a second smaller flap is indicated in the same manner. The incision begins a short distance in front of the base of the upper flap and circles the lower portion of the penis in a plane at right angles to the long axis of the organ. The upper flap is next dissected back to its base, disclosing the corpora cavernosa. These bodies are amputated, care being taken to leave an ample length of corpus spongiosum and urethra projecting beyond the cut cavernous bodies. (Fig. 495.) The vessels are tied and the sheaths of the corpora cavernosa are sutured. The larger upper flap is perforated with a knife at a point which will lie over the protruding urethra when the flap is drawn down over the stump. The urethra is passed through the opening in

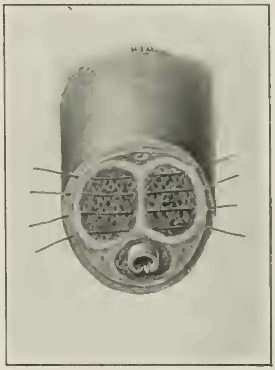


FIG. 495.—Partial Amputation of the Penis; First Step. (After Hartmann.) The corpus spongiosum has been resected at a point situated anteriorly to that at which the corpora cavernosa have been divided. The urethra is split in the middle line, inferiorly. The stitches to be employed in suturing the corpora cavernosa are shown in their proper positions, ready to be tied.

the upper flap and is then sutured in place, after having been split transversely to prevent stricture. The two skin flaps are finally attached together with interrupted sutures. (Figs. 496 and 497.)

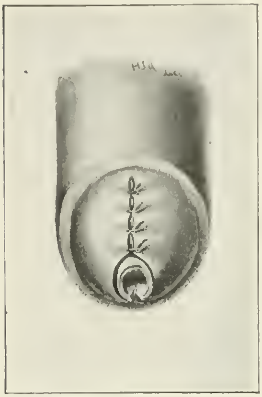


Fig. 496. Partial Amputation of the Penis; Second Step. (After Hartmann.) Suture of the sheath of the corpora cavernosa after ligature of the cavernous arteries.

Complete amputation of the penis may be done by an extension of the Nicoll operation above described. The circular penile incision is made through the skin at the root of the organ, the crura are dissected away from their pubic attachments, and the whole penis is removed, about half an inch of urethra being left projecting from the wound. The stump of the urethra is then split and its margins are sutured to the edges of the skin wound, thus making a new external urinary meatus. If it be desired to avoid the irritation of urine flowing from this opening over the scrotum, the distal end of the urethra may be cut short and a permanent perineal fistula established by opening the deep urethra through a median perineal incision. In very far advanced cases, some authors recommend also the removal of the entire scrotum and both testes. Sometimes a perineal meatus, constructed as above described, develops a persistent and inconvenient tendency to close. To avoid this possibility, the scrotum may be split at the original operation and the urethra dissected free, brought down and cut off, and left protruding from the perineum. Such a stump shows no tendency to close and acts admirably as a spout for the discharge of urine.

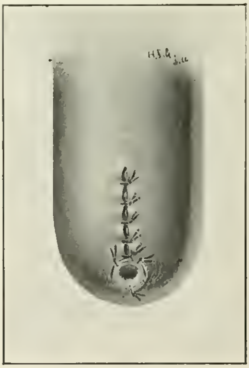


Fig. 497.—Partial Amputation of the Penis; Third Step. (After Hartmann.) Above, the skin is sutured over the corpora cavernosa; below, the projecting urethra is sutured to the skin.

(*b*) Tumors of the Urethra.—Tumors of the urethra are not common. For their early and accurate diagnosis endoscopy is essential.

Papilloma.—Papilloma occurs as a simple polypoid hyperplasia of the mucous membrane, sessile or pedunculated.

Angioma.—Angioma is a tumor of similar nature, but more vascular, like a caruncle.

Both these tumors are usually situated in the anterior urethra. They are benign and almost symptomless, unless large enough to cause obstruction, or so vascular as to bleed on micturition. Papilloma may cause a slight gleety discharge. The treatment of these small tumors is removal through a urethral speculum by means of snare, scissors, or forceps, and cauterization of the base with silver nitrate or glacial acetic acid.

Cyst.—Cyst of the urethra is extremely rare. In a case of Dr. Hugh Cabot's, the small tumor, as shown in Plate XLVII, Fig 2, was situated at the meatal orifice and was filled with clear fluid. It was excised and the base cauterized.

Calcification.—Calcification of the urethra is rare, but has been reported. In the case of Dr. Cabot's, cited farther on, fragments of the calcified wall of the urethra used to shell off, like mica scales, become impacted in the urethra, and cause obstruction. The treatment is periodic removal of the scales through a speculum.

Carcinoma.—Carcinoma is very rarely primary in the urethra, but occurs not infrequently as a secondary extension from cancer of the penis. When primary, it is generally situated in the perineal portion of the urethra; when secondary, it may extend up from the meatus or invade the urethral wall by direct growth through the body of the penis. Venereal disease hardly seems to be a predisposing cause, or the condition would be much commoner than it is. The symptoms are pain and difficulty on micturition, and later a foul purulent discharge from the urethra. In advanced stages a tumor appears in the perineum and may slough through the skin and form a fistula. The condition is commonly mistaken for stricture, periurethral abscess, or urethral calculus. It should be early recognized by the discovery, in the urethra, of a hypertrophic ulceration, not definitely proved to be of other cause; and unexplained symptoms of the above nature should suggest prompt endoscopy and the removal of a small bit of tissue, an examination of which will settle the diagnosis. The treatment is radical excision of the growth. The prognosis is poor, since the majority of these patients die of recurrence in the scar and of metastasis.

(*c*) TUMORS OF THE SCROTUM.—Tumors of the scrotum are rare.

Lipoma.—Lipoma is one of the more frequent tumors of this region. It may attain such size as to be mistaken for a testis, or even to envelop the testes in its growth.

Fibroma.—Fibroma is very rare. It may also, like the lipoma, attain considerable size. It sometimes follows trauma.

Enchondroma.—Enchondroma is very rare. It is a harder tumor than fibroma, and conveys to the hand, when pressure is made, a sensation of being decidedly elastic.

All these tumors are benign, and their treatment is excision.

Angioma.—An angioma of the scrotum, whether in the form of a well-defined nævus or in simply that of a highly vascular growth, is usually congenital. The treatment is ligature and excision of the tumor and cauterization of its base.

Cysts.—Cysts of the scrotum are fairly common. They may be dermoids (already described on page 637), sebaceous cysts or wens, and simple cysts filled with clear fluid. The treatment is excision.

Sarcoma.—Sarcoma is very rare. It may be primary in the scrotum, or, more usually, secondary to a sarcoma of the testes. Melanotic sarcoma is occasionally seen. Operation must be radical, with dissection of both groins; but it should not be undertaken if there are metastases in the lung or the liver.

Carcinoma.—Carcinoma is the common malignant tumor of the scrotum (Fig. 498), but is much less frequent than cancer of the penis. It is usually of the squamous-celled, epitheliomatous type, though medullary and scirrhous forms have been reported. The disease used to be almost entirely confined to England and to the class of chimney-sweeps,—so much so, indeed, that it is known as "chimney-sweep's disease." It was supposed to be due to the peculiarly irritating qualities of pit-coal soot and sweat in the clothing; and it is a singular fact that the disease occurred in the sweeps of other countries, where pit-coal was not so much used for fuel. Nowadays it is seen chiefly among smelters and those who work in coal-tar products, paraffin, and guano. Primary cancer of the scrotum begins as a crusted wart, which may remain inactive for years before it finally takes on a papillomatous, ulcerating growth. The scrotum may also be involved secondarily from cancer of the testis, and conversely. The treatment is early, radical excision of the tumor, with subsequent plastic operation to repair parts destroyed, if necessary. The prognosis, with thorough operation, is fairly good.

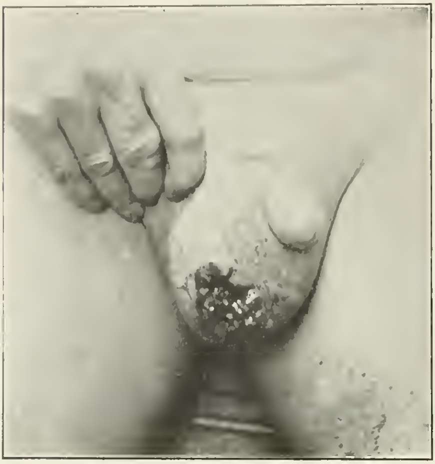


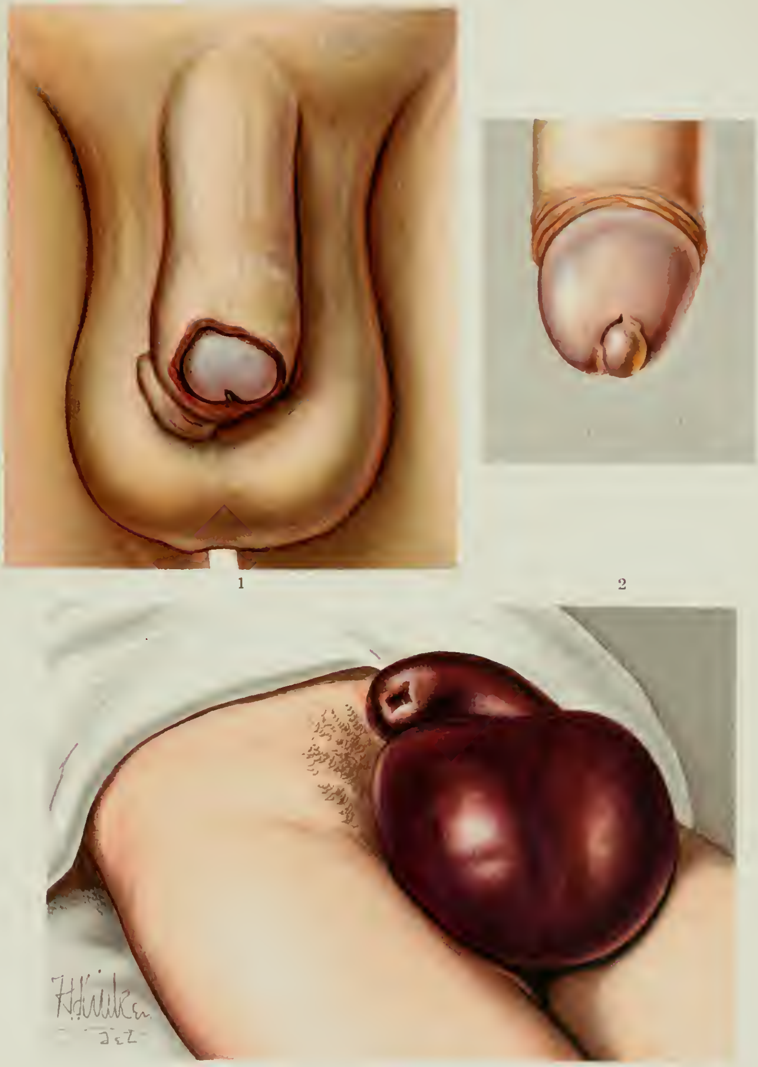
FIG. 498. Cancer of the Scrotum. (Courtesy of Dr. J. Collins Warren, Massachusetts General Hospital.)

(*d*) TUMORS OF THE TESTES, EPIDIDYMIDES, AND SPERMATIC CORDS.—Under this heading are included:—Fibroma, calcification, enchondroma, cysts, myxoma, myoma, carcinoma, and sarcoma.

Fibroma.—Fibroma is usually multiple and generally has its seat in the tunica vaginalis. It may also occur after trauma, representing a residual organization of a hæmatoma. The treatment is removal. When the tumors are multiple, the entire tunica vaginalis may need to be dissected out, as in the radical cure of hydrocele.

Calcification of the Tunica Vaginalis.—Calcification of the tunica vaginalis is very rare, but may occur, especially in connection with calcification of the urethra. In the accompanying *x*-ray picture (Fig. 499), of Dr. Hugh Cabot's case, the calcified tunica is seen as a shell partly enveloping the testis. The condition is usually symptomless and requires no treatment.

Enchondroma.—Enchondroma may occur as a tumor of the body of the testis or of the epididymis. It is hard, elastic, painless, slow-growing. Its treatment is removal.



Various Lesions of the Penis and Scrotum

Cysts.—Cysts are rarely observed in these parts. They occur in several distinct forms:—(*a*) Simple cyst of the testis—unilocular, filled with clear fluid, perhaps sometimes representing the degeneration of an enchondroma.—(*b*) Cysts of the hydatids of Morgagni—multiple cystic remnants of the embryonic ducts of Mueller. They are filled with clear fluid, and occur particularly in children.—(*c*) Cyst of the organ of Giraldès—a unilocular cystoma, usually attaining greater size than cysts of the hydatids of Morgagni, but otherwise clinically indistinguishable from them.—(*d*) Dermoid cyst or teratoma—a solid mixed tumor of the testis, containing a heterogeneous accumulation of hair, bone, sebaceous material, cartilage, sometimes brain, teeth, and other organs in rudimentary form.

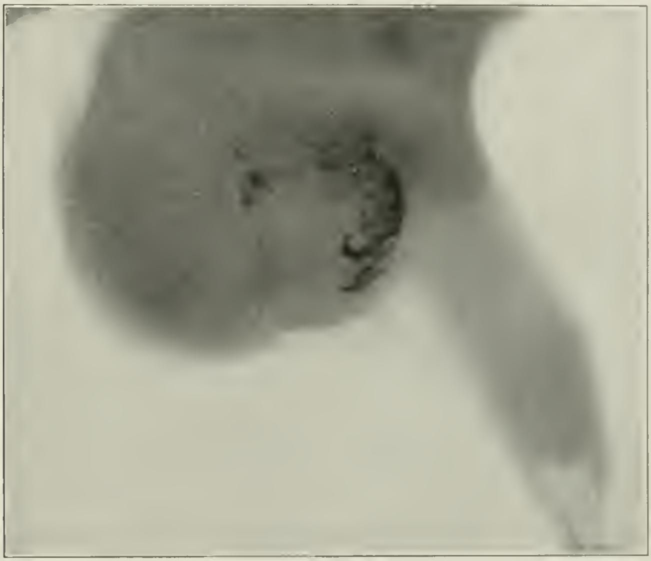


Fig. 499.—Calcification of the Tunica Vaginalis and Urethra. (Courtesy of Dr. Hugh Cabot, Massachusetts General Hospital.) *X*-ray shows the calcified tunica surrounding the testis like a shell.

These tumors are usually independent of the testis to which they may be attached only by a pedicle. Sometimes they are sessile, but even then they can usually be dissected out at operation without injury to the testis. The chances of saving the testis are better if the operation is performed before puberty.

The treatment of all these forms is removal, since their increase in size may cause pressure atrophy of the testis.

Myxoma.—Myxoma is a rare primary tumor of the testis.

Myoma.—Myoma is equally rare, and originates from the muscle fibres of the testicular sheaths.

Carcinoma.—Carcinoma of the testis is rare. It may be medullary or scirrhous. It is always unilateral, and, as it grows, it infiltrates the spermatic cord and seminal vesicles and at the same time invades the lymph nodes in the groin. It is hard, nodular, and accompanied by pain and loss of weight. The differential diagnosis of all testicular tumors is difficult, and that of cancer from sarcoma often cannot be made at the bedside. In either case the treatment is radical removal.

Sarcoma.—Sarcoma is the common malignant tumor of the testis; it originates from the connective-tissue framework of the gland. Like other sarcomata, it frequently follows trauma. It may be of the round-celled, spindle-celled, or melanotic variety. The latter is particularly malignant, and is liable to be associated at an early date with metastases in the liver. The tumor is firm, but softer than cancer, generally painless, and unilateral. It is sometimes accompanied by hydrocele. The fact that the lymphatics of the testis drain into the iliac and retroperitoneal, instead of into the inguinal lymph nodes, explains why high internal extension of the disease occurs early and proves fatal. Extension up the cord and involvement of the iliac and retroperitoneal lymph nodes and of the prostate may cause œdema of the external genitals from interference with the lymphatic circulation. Sarcoma of the testis is fairly common in youth and young manhood. An undescended testis is probably more liable to the disease than one normally placed. This fact is one argument in favor of removing such testes after puberty. When the testis remains within the abdomen, cystic degeneration or the development of a sarcomatous process in it may produce obscure symptoms of abdominal tumor which are not likely to be appreciated until the growth has gone beyond surgical relief. Whatever the situation of the testis, the treatment of the sarcoma is orchidectomy with liberal excision of all other involved tissues.

The operation of orchidectomy is performed by making a high linear incision, just under the external inguinal ring. Through this opening the testis is delivered after being isolated. The cord is then drawn down and tied as high as possible, not *en masse,* but by picking up its several structures *seriatim.* The greatest care must be exercised not to tie while the cord is under tension, lest the vessels may subsequently retract through the ligatures and serious and even fatal hemorrhage ensue. The cord is then cut and the testis removed. The procedure is essentially the same, for whatever cause the operation be done. In cases of tuberculosis, it is not necessary to remove any of the scrotum or other tissues secondarily involved. In malignant disease, everything that gives the slightest evidence of involvement must be removed with a wide margin. After orchidectomy for tuberculosis, the scrotal cavity should be wiped out with tincture of iodine and drained. In malignant disease it is desirable to avoid drainage, if possible. Bilateral orchidectomy, or castration, is done by the same technique, preferably with two incisions.

(*e*) TUMORS OF THE SEMINAL VESICLES.—These include cysts and carcinomatous growths.

Cysts.—Cysts of the vasa deferentia and seminal vesicles are occasionally seen, and may attain great size. They may be tapped and drained through the rectum; but the risk of infection is great, and the cysts may refill. A better treatment is to expose the tumor, through a perineal incision, and then to dissect out the sac, thus effecting a radical cure.

Sarcoma and Carcinoma.—Sarcoma and carcinoma are generally secondary to disease in the bladder, prostate, or testis. Rarely, they may be primary in the seminal vesicles. The diagnosis depends on symptoms of vesicular irritation, and on the determination, by rectal palpation, of an indurated, nodular tumor in the region of the vesicles. In the early stages, a cure may be effected by removal of the growth through a perineal incision; but recurrence is likely and the prognosis is generally bad.

CHANCROID.

By HUGH CABOT, M.D., Boston, Massachusetts.

ONE of the most striking achievements of the last half of the nineteenth century was the establishment of the essential difference between chancroid and chancre, the primary lesion of syphilis. Until this was discovered the two conditions were constantly confused and many serious and even disastrous results followed the failure to recognize the essential difference. The confusion was in part due to the fact that both most commonly appear as genital ulcerations and in part to the fact that the infections may be and frequently are mixed, so that a typical chancroid may, as it develops, take on the equally typical characteristics of a chancre and thus render confusion worse confounded. The distinction is now entirely clear, and with modern methods of diagnosis serious error should not occur.

Chancroid has been properly regarded as the most venereal of all so-called venereal diseases, wherein it sharply differs from syphilis, which is perhaps the least venereal. In this community, at least, the disease is much more common in that class of the population which is generally seen at the public clinics,—in that class, in short, in which careless habits and lack of cleanliness are most common, and in which, when the disease attacks an individual who is ill-nourished and whose resistance is low, its most virulent manifestations occur.

ETIOLOGY.—Chancroid is caused by a bacillus which is commonly spoken of as the Ducrey or Ducrey-Unna bacillus. It was first described by Ducrey, in 1889, in pus taken from the surface of a venereal ulcer. Shortly afterward Unna described what he termed a strepto-bacillus found in the tissues of a soft chancre. The work of Peterson, Nicolle and Cheinesse, in succeeding years, demonstrated the identity of the organisms described by Ducrey and Unna. Bezançon, Griffon, and Le Sourd succeeded in cultivating the organism about 1901, and finally the excellent work of Davis, in 1903, closed the chapter. He succeeded in cultivating the organism from genital and extra-genital lesions and in reproducing the lesion in a monkey.

Characteristics of the Ducrey-Unna Bacillus.—The bacillus is a short, thick organism, about 1.5μ in length and 0.5μ in thickness, with rounded, deep-staining ends and a more faintly staining central portion. It is found both singly and in masses, and often shows a characteristic chain arrangement, particularly in stained sections of tissue. It takes the basic aniline dyes readily and is decolorized by alcohol and by Gram's solution. It grows best on freshly prepared human blood, freely on fresh blood and bouillon medium, not at all on ordinary media. It is regularly found on the surface of chancroidal ulcers and in the tissues of the ulceration; much less regularly it has been reclaimed from the pus of a chancroidal bubo. The entirely specific character of the organism is beyond doubt.

THE LESIONS OF CHANCROID.—*Frequency of Occurrence.*—The frequency with which the lesion will be seen by any particular observer will depend largely upon the class of practice in which he is engaged. As already noted, it is very commonly seen in the genito-urinary clinics of the public hospitals, and, with the exception of gonorrhœa, it is perhaps the most common genital lesion. On the other hand, among the better class of the population it is not a common disease; while in the best class of private practice it is a distinct rarity.

Period of Incubation.—Properly speaking there is no incubation period, although the development of the lesion may be very slow and may not attract attention for a few days. Under favorable conditions it develops within from twenty-four to forty-eight hours after infection, and, although at this time its presence is frequently overlooked, it is readily detected by the careful observer. One frequently sees patients, however, who insist that the time between exposure and the development of the lesion is much longer, often a week or ten days. This apparent discrepancy is due to one of two causes: Under conditions which are unfavorable to the lodgment of the organism it may fail to find an entrance into the tissue for some days; although in uncleanly individuals it may succeed in holding its ground. The second and the most probable explanation is to be found in the peculiar inability of patients who are affected with a disease of this nature to remember accurately or to observe correctly. The entire absence of an incubation period, when satisfactorily demonstrated, is an important aid to distinguishing the lesion from the primary lesions of syphilis.

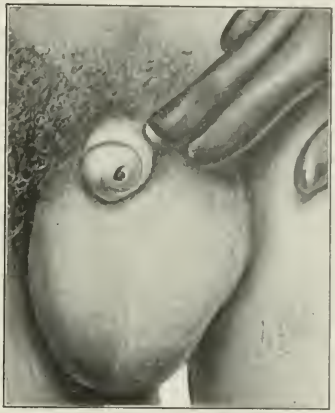


FIG. 500.—A Mild Type of Chancroidal Ulcer.

Site of the Lesions.—The lesions are almost habitually found on or about the genital region. The most common sites are on or near the frenum or in the coronal sulcus. The prepuce, either on the free border or on its outer surface, is another region often affected. Lesions are frequently seen upon the neighboring parts of the abdomen, thighs, and scrotum. In these situations they are commonly implantation lesions due to the ready auto-inoculability of the organism. Outside of the regions just named, chancroidal ulcers are of the greatest rarity. Peterson collected 9,000 cases of chancroid, of which number only 8 were extragenital. Of those 8, 5 were situated upon the fingers. Ullman collected 64 cases of extragenital chancroid from the literature. Of these

61 cases, there were 22 in which the lesion was on the finger, the other sites being the mouth, lips, eyelids, and other parts of the face. This decided rarity of extragenital lesions is in rather marked contrast to the lesion of syphilis, which is not infrequently extragenital.

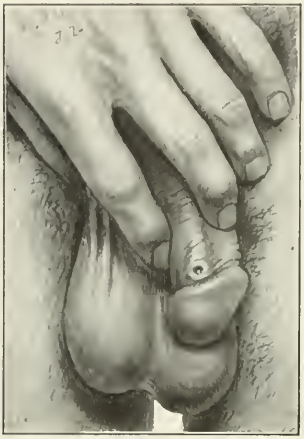


FIG. 501.—Early Mild Chancroidal Lesion.

Character of the Lesions.—In typical cases the process begins as a pustule, but the covering is soon torn off and when first seen the lesion is a little ulcer. (Figs. 500 and 501.) This ulcer has a grayish, sloughy base, entirely free from hardness or induration, and an abrupt or undercut edge, often quite characteristic. The secretion from the surface is purulent, in some contrast to the serous secretion of chancre. Though always beginning as a small ulcer, the lesion often increases rapidly in size and frequently assumes considerable proportions. At the same time multiple lesions are very common, being due, as above suggested, to autoinoculation. (Fig. 502.) In this way a lesion on the corona will frequently show a corresponding lesion on the apposed surface of the prepuce, and the extension of these two ulcers may soon cause them to fuse together into one large lesion.

The appearance of certain of the more common lesions is quite characteristic and may be worthy of description. When the lesion is situated on the frenum it may in most cases be assumed that the virus has entered through a small fissure. The lesion presents the appearance of a narrow ulcer which rapidly spreads and involves, first, the apposed surface and soon afterward the greater portion of the frenum. (Fig. 503.) Ultimately the frenum may be entirely destroyed. Pain is apt to be felt when the last few drops of urine come in contact with the lesion. (Fig. 504.) When situated on the corona or in the coronal sulcus the multiple lesions scattered over this region rapidly spread and become confluent, producing a collar-like ulcer, which may nearly encircle the glans. Another rather common site of the lesion, in cases of moderate phimosis, is on the free border of the

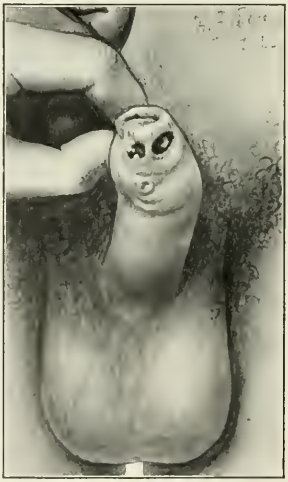


FIG. 502.—Multiple Chancroidal Ulcers.

prepuce. Here, while the lesion is at first single, rapid multiplication takes place, and there is presented a nearly circular ulceration of characteristic appearance. (Fig. 505 and Plate XLVII, Fig. 1.) Lesions upon the free surface of the prepuce are likely to be more benign than those situated in the neighborhood of the glans, probably because the absence of heat and moisture makes the culture medium less favorable. (Fig. 506.) By the same token lesions on the thigh and abdomen are commonly less difficult to handle, while those on the scrotum are often troublesome because situated in the folds where heat and moisture are present. (Fig. 507.)

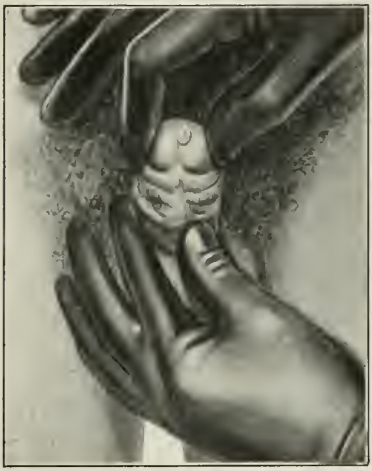


Fig. 503.—Two Chancroidal Ulcers on the Inner Surface of the Prepuce near the Frenum. Drop of urethral discharge at the meatus.

Subjective Symptoms.—The ulceration of chancroid is characteristically painful. Frequently the lesion is exquisitely sensitive, though in some instances it may be quite insensitive. This characteristic will often differentiate it from the strikingly insensitive lesion of syphilis.

Duration.—The lesions are very apt to be sluggish and resistant to treatment. When the disease is actively virulent the average duration is from three to six weeks, and it shows many of the characteristics of a self-limited disease. The more severe lesions may continue to persist for weeks or months; indeed, in cachectic and ill-nourished individuals the ulcers may persist for a year or more in spite of efficient treatment.

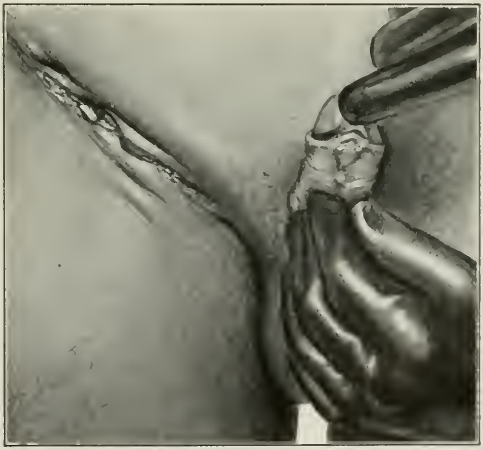


Fig. 504.—Chancroidal Ulcer has Destroyed the Frenum, and the Groin Shows the Scars of a Drained Bubo.

Complications.—*Simultaneous Infection with Chancroid and with Syphilis.*—The "mixed chancroid," as already noted, was one of the most serious obstacles to the establishment of the distinction between chancroid and chancre. The two diseases may infect an individual simultaneously; the long incubation period of syphilis causing the characteristic lesions of this disease to make their appearance only after the lapse of two or three weeks, while during the whole of this period the chancroid will have been present. It may also happen that a chancroidal ulcer already existing may be the site of inoculation for a later syphilitic infection, and the modification of the lesion may therefore occur at any period of its existence. In typical cases the chancroid begins to change in character during the second and third weeks; the base becomes indurated and some of the specific characteristics of chancre manifest themselves. (Fig. 508.) The superficial appearance of the lesion, however, is usually more characteristic of chancroid than of syphilis. But there are cases in which the characteristics of either disease may predominate, and it is in these cases that an erroneous diagnosis is apt to be made. Instead of recognizing the fact that both kinds of infection have taken place, the observer adopts that diagnosis which is in harmony with the more striking characteristics presented.

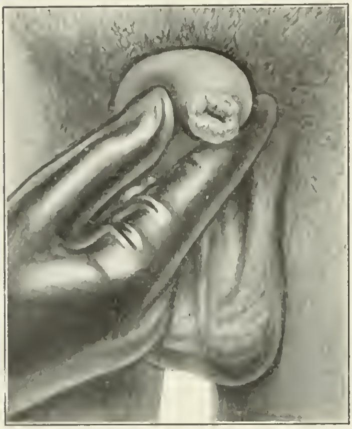


Fig. 505.—Chancroidal Ulcers around the free Border of the Prepuce.

With the local changes there will in due time be associated the alterations in the lymph nodes which are characteristic of syphilis. Still later, the secondary lesions will appear, at times to the dire confusion of the practitioner who has rashly given an incorrect opinion in regard to the earlier appearances.

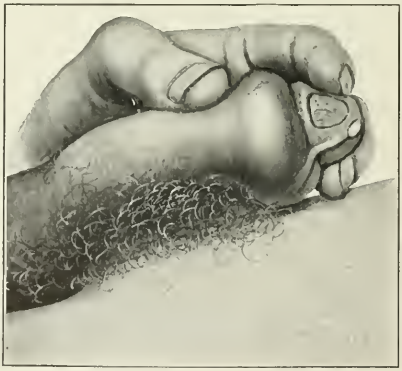


Fig. 506.—Chancroid on the Glans.

Phimosis.—Phimosis, as a complication of chancroid, may be either congenital or acquired. Phimosis of the congenital type complicates the condition from the start, while in the acquired form it results from the œdematous swelling which constricts an already tight prepuce. (Fig. 509.) Its importance as a complication is due to the fact that it renders the lesion inaccessible and, by imprisoning the natural secretion of the parts, favors activity and extension of the chancroidal process. It at times gives rise to a sort of vicious circle, in which the imprisoned secretion causes œdema, and this, in turn, lowers the vitality of the tissue, increases the activity of the ulceration, and in time may impair the circulation to so serious a degree as to threaten or actually to produce gangrene and sloughing of certain portions of the prepuce. (Fig. 510.) When sloughing occurs it usually takes place on the upper surface and makes a hole through which the glans protrudes. It should be said, however, that these serious consequences are rare if the patient is properly cared for.

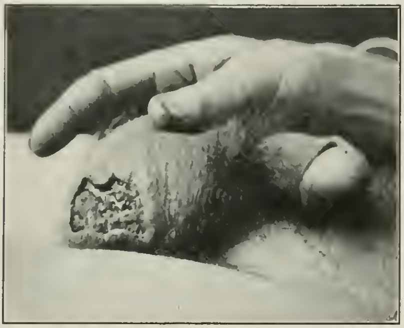


Fig. 507.—Chancroid of the Scrotum.

Phagedena.—The term phagedena, or phagedenic ulcer, is applied to any form of ulceration which, so to speak, tends to "run wild." It is in no sense peculiar to chancroid and may occur in any ulceration affecting an unhealthy individual. (Fig. 511.) It is characterized by a rapid extension of the process, by the difficulty which one usually encounters in the attempt to control it, and by the large amount of the tissue destroyed before it is finally mastered. (Fig. 512.) Some of the most intractable cases occur after the spontaneous rupture or the artificial opening of a virulent chancroidal bubo, when the whole region may be converted into a huge ulcer, which extends over the region of the groin, and up over the abdomen, and which may persist for many months. The condition seems to be due to low resistance on the part of the patient rather than to any peculiarities of the infecting organism.

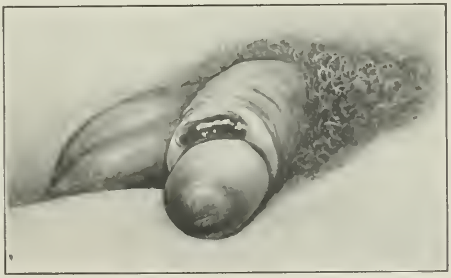


Fig. 508.—The Mixed Lesion. This shows well the stiffening of the tissues which makes the prepuce roll back in a characteristic way.

Lymphangitis, Lymphadenitis. (*Bubo.*) Lymphangitis is not infrequently associated with chancroid and is of the typical inflammatory type. The lymphatics along the dorsum of the penis are tender, swollen, and red, and they occasionally break down and form local abscesses and ulcers. The condition is readily distinguishable from the lymphatic involvement which accompanies the primary lesion of syphilis, in which the lymphatic channels are hard, indurated, and nodular, show neither redness nor tenderness, and never break down or form abscesses.

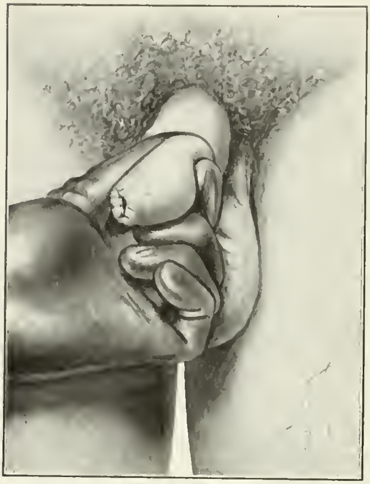


Fig. 509.—Phimosis due to Chancroidal Ulceration.

Lymphadenitis or involvement of the lymph nodes in chancroid is a more dignified term for the historic "bubo," often vulgarly spoken of as a "blue ball." It is a common complication of chancroid and not infrequently forms the most important and lasting evidence of the disease.

Frequency of Occurrence.—The frequency of involvement of the lymph nodes in chancroid has been variously estimated at from ten to thirty per cent, the difference in these estimates being probably due to the character of the material seen. We shall not be far from the facts, if we assume that we shall see this secondary lesion in about one-third of the cases.

Time of Occurrence.—The bubo does not appear until during the second or third week of the ulcer. It not infrequently happens that the ulcer is so insignificant as to escape attention, while the bubo is the symptom for which the patient seeks advice. The ulcer is discovered only on careful examination by the surgeon. Furthermore, the ulcer may have entirely healed and have left no discoverable trace when the patient presents himself with a bubo. Under these circumstances it is not always possible to make a positive diagnosis. The origin of the ulcer may always be suspected from the character and relative intractability of the disease of the lymph nodes.

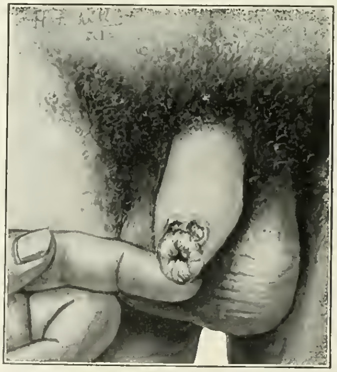


Fig. 510.—Phimosis Complicating Chancroid. In this case sloughing of the prepuce threatened, but was checked and is here shown in the subsiding state.

Peculiarities of the Chancroidal Bubo.—The bubo of chancroid is typically an inflammatory lesion, thus distinguishing it from the non-inflammatory adenopathy of syphilis. One or several lymph nodes may be involved. They are adherent to the surrounding structures and to each other and they tend to coalesce, break down, and form an abscess. (Fig. 513.) The bubo may be unilateral or bilateral. In unilateral cases the involvement of the lymph nodes may be on the opposite side from the ulcer, thus demonstrating the irregular course of the lymphatics. (Fig. 514.) The demonstration of the Ducrey-Unna bacillus is by no means always possible, and it has been found only in about one-third of the cases,—whether because it does not exist in the pus at that time, or because the technique is faulty, it is impossible to say.

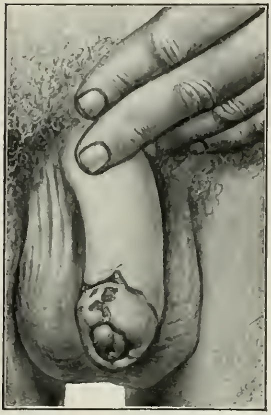


Fig. 511.—Late Appearance of a rather Active Ulceration.

The course of the chancroidal bubo is distinctly chronic. In typical cases the small and tender lymph nodes go on steadily growing until a large mass forms in the groin in the course of ten days or two weeks. The skin at this time is œdematous, red, and tender; if the inflammation is allowed to continue the pus will finally break its way out and continue to escape from the abscess, but this is by no means the end of the process. The remaining lymph nodes have small foci of suppuration deeply placed in their substance, and these continue to grow, break down, and discharge for weeks or even months. There is perhaps no other form of abscess the spontaneous rupture of which is so rarely followed by cure in a reasonable time. In the more virulent cases, after the abscess ruptures or has been incised, the edges of the opening become infected with the organism and a typical chancroidal ulceration results, which may extend slowly, persist almost indefinitely, and in time destroy much tissue. Such cases as the latter are fortunately rare.

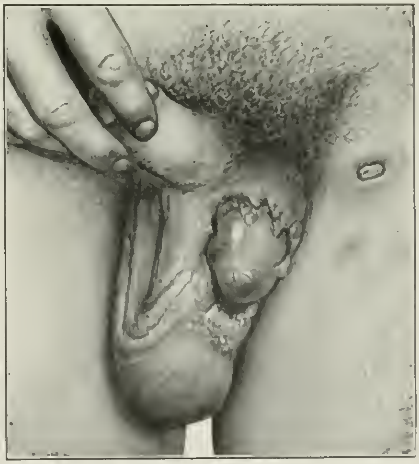


Fig. 512.—An Extensively Destructive Lesion here Shown in the Declining Stage, the testicle having been exposed but not destroyed.

Diagnosis of Chancroid.—Chancroid must be distinguished, on the one hand, from a simple ulceration, such as may come in balanitis, and from chancre on the other. From simple ulcer it is readily distinguishable by its indolence and frequently by the formation of a bubo; in short, its course is strikingly different. From chancre it may be distinguished by its lack of an incubation period, if this can be determined, by the entire absence of characteristic induration, by the greater activity of the process, by the more typical inflammatory appearance, and by the characteristic involvement of the lymph nodes, which in chancroid is typically inflammatory, while in chancre it is clearly non-inflammatory. On the other hand, it is never safe to assume that the chancroid will not prove to be a mixed infection, and therefore, during the first three or four weeks, it will be the part of wisdom to give a guarded opinion. Time will practically always clear up all difficult questions, as the chancroid with proper treatment will heal, while the chancre will develop secondary lesions and show unmistakable evidence of its syphilitic nature. Where, owing to the presence of phimosis, the lesion cannot be directly seen, the diagnosis may be more difficult. Chancroid will, however, show much greater activity and, owing to the inoculability of its virus, ulceration along the free border of the prepuce is a common event. Furthermore, it is generally easy to feel the induration of chancre, even through the

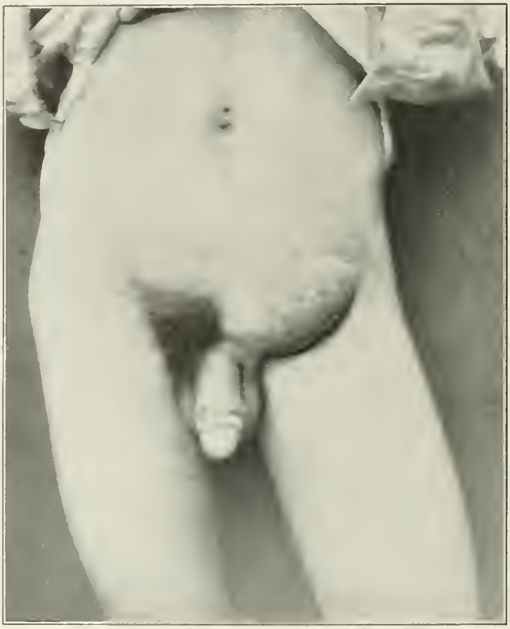


Fig. 513. A Well-developed Bubo in a Patient Affected with Chancroid.

tissues of the swollen prepuce, and in fact the amount of induration seems to be greater in the chancres which are imprisoned behind a phimosis. The character of the lymph-node lesions in the groin will frequently aid in the diagnosis.

Chancroid occurring in phimosis may be distinguished from balanitis by the greater activity of the process, by its duration, and in many cases by the formation of the typical bubo.

Lastly, where facilities are at hand, the demonstration of the Ducrey-Unna bacillus in chancroid, or of the Spirochæte pallida in syphilis, is frequently possible and always puts an end to doubt.

Prognosis.—The prognosis as to life is practically always good. On the other hand, the marked indolence of the lesion should always be remembered and the patient should be warned that the ulcer may be slow in healing. The occurrence of a bubo, which greatly lengthens the course of the disease, and the possibility of the lesion being a mixed one, make it important that the patient should be kept under observation until the ulcer is definitely healed or until a sufficient time has elapsed to render the development of syphilis impossible. In rare cases, particularly in ill-nourished patients or those of low resistance, phagedenic tendencies may appear. When this occurs the outlook may be grave, and the prognosis as to time is always very uncertain in these cases. The wise practitioner will refrain from expressing a positive opinion as to the duration of the ulceration until the course of the disease makes it clear that the case belongs either to the tractable or to the more intractable type.

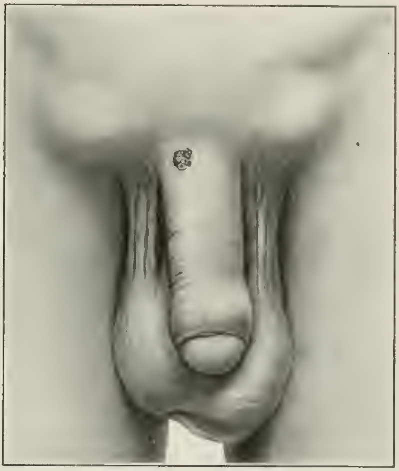


Fig. 514.—Bilateral Bubo. Both sets of inguinal lymph nodes have here been infected by a right-sided chancroidal lesion.

Treatment.—The treatment of chancroid practically divides itself into two parts: the treatment of the ulcer, and the treatment of the lymph-node involvement.

Treatment of the Ulcer.—Although the nature and the peculiarities of these ulcers have been known and understood for a long time, little has of late years been added to our ability to heal the lesion. The number of methods advocated and used in its treatment bears eloquent testimony to the efficiency of none. This is in part due to the nature of the lesion and in part to the nature of the patient. As above noticed, there is much in the condition which suggests a self-limited disease, and it is not uncommon to see a lesion persist and increase in size in spite of the most energetic measures. The peripatetic habits of the class of individuals in whom these lesions are most commonly found, make it often impossible to insist on regular and systematic treatment, and in the more severe cases, in which the patient ought to be confined to bed, it is frequently impossible to obtain hospital accommodations owing to the unenlightened rules of many of our hospitals, which exclude this type of disease for sentimental though thoroughly unsound and unscientific reasons.

The Use of the Milder Antiseptics.—The basis of all treatment of the ulcer is cleanliness and antisepsis; neither is efficient without the other. As a matter of convenience these antiseptic measures may be divided into mild and strong antiseptics. In all cases the lesion should be carefully washed two or three times a day, and I am not clear that any solution is notably more efficient than warm water. The affected part may then be thoroughly bathed with a saturated solution of boric acid or with a solution of carbolic acid (1 : 50) or of corrosive sublimate (1 : 5,000). Each of these solutions has its advantage, but it has seemed to me that carbolic acid was somewhat the more effective. After the solution has been thoroughly applied for not less than twenty minutes, the parts should be carefully dried and powdered. Here again a great variety of powders have been advised. Of these, boric acid, calomel, boric acid and talcum powder in equal parts, subgallate of bismuth (dermatol), and aristol may perhaps be taken as types. It is not clear to me that any one of these has a notable advantage over the others, but in my own practice I have found that boric acid for mild lesions and calomel for the more severe ones, are efficient. Iodoform was once extensively, almost universally, applied, but it has no notable advantage over the others and its disagreeable odor makes it offensive to the patient as well as to the community. Its use is not to be advised. Within reasonable limits the beneficial results will be in almost direct relation to the frequency and thoroughness of the treatment. The hospital patient who is treated once daily, or even less often, frequently will show much less satisfactory progress than the patient who is seen daily by the surgeon and who repeats the application himself two or three times between visits.

The Use of Strong Antiseptics.—The superficial nature of the lesion and its direct dependence upon the action of bacteria which are situated close to the surface have made the use of very strong caustic solutions or applications attractive. Of these, nitric acid, carbolic acid, absolute alcohol, and the actual cautery are the most common. They aim to destroy completely the causative agent together with the superficial tissue, and when advisedly used they are often efficient. On the other hand, they are open to distinct objections. They not infrequently fail because they do not entirely abolish the cause, and by lowering the vitality of the tissue they render reinfection easy. Furthermore, they have a very marked tendency to produce induration of the base of the lesion and thus render it difficult to distinguish it from mixed chancroid or from chancre. This latter objection becomes more important on account of the fact that these patients frequently migrate from one clinic to another and, in the absence of accurate and continuous knowledge, these lesions at times become very confusing. In general, it has seemed to me wiser to confine the use of these strong antiseptics to the more actively virulent ulcers and it is rarely wise to make very frequent applications. The occasional use of strong solutions, coupled with the continued use of mild ones, will prove satisfactory for the average case. In the virulent types active measures are more valuable and may be used with less hesitation.

Nitric acid should be applied directly to the ulcer, a small wooden applicator being used for this purpose and the surrounding tissue being protected with vaseline. After two or three minutes the acid should be removed by neutralizing the excess with a saturated solution of sodium hydrate. The application is painful but efficient.

Perhaps the more generally useful agent is crude carbolic acid, the application of which should be followed by the use of absolute alcohol. The application should be made in the same way as above suggested, and after two or three minutes absolute alcohol should be applied. This promptly neutralizes the acid and leaves a clean soft base. The anaesthetic properties of carbolic acid make it a distinctly less painful application.

In severe cases the actual cautery is the most efficient agent. I have seen it check, like magic, a virulent chancroidal ulcer of the groin resulting from a bubo. It causes a great deal of pain and should not be employed, except for lesions of very limited extent, unless the patient has been anaesthetized. The cautery should be applied at a dull-red heat and the whole superficial tissue should be thoroughly destroyed. When the actual cautery is indicated, it should be employed in a thorough manner; half-way measures simply do harm.

Excision.—The total excision of a chancroid, a measure which has been advocated from time to time for many years, was prompted by a laudable desire to abolish the lesion at one fell swoop. The value of the procedure, however, is much restricted by the fact that, in many of the positions in which chancroid most commonly occurs, a thorough-going excision is quite out of the question on account of the necessity of removing an excessive amount of tissue. But, even where a chancroid is situated in lax tissues, excision, as usually carried out, by no means always puts an end to the process; indeed, it not infrequently substitutes a large for a small ulcer. It is rarely to be advised except for the purpose of obtaining tissue for histological examination.

Modification of the Treatment in the Severe Cases.—When, in spite of reasonable measures, the ulcer extends and becomes virulent, confinement to bed, with its attendant possibilities of more efficient treatment, is certainly to be advised. Frequent applications of mild antiseptics or even long-continued soaks will often check apparently intractable lesions. In these severe conditions active measures like the cautery, closely followed by the careful and thorough use of mild solutions, will in most cases promptly turn the process from a virulent to a benign one. Unfortunately, accommodations for these patients are difficult to obtain.

Treatment of Phimosis.—Chancroid complicated by phimosis is always more difficult to manage. The majority of these cases can be controlled by frequent irrigation of the preputial sac with mild antiseptics. Soaking the parts for an hour or two a day in mild hot antiseptic solutions is frequently beneficial. In some cases, in spite of these measures, the active process persists and gangrene threatens. Under these circumstances exposure of the lesion is indicated. It is better simply to slit the prepuce up the dorsum and thus expose the lesion than to attempt a circumcision through tissue practically always infected. It has seemed to me that these cases do better when the incision is made with a cautery-knife or when it is made with the ordinary knife and the edges of the cut are promptly cauterized. These patients do very much better if they can be confined to bed.

Treatment of Bubo.—The appearance of a well-defined bubo is always discouraging, since it means that the course of the disease will be much prolonged,—in the worst cases for months.

Intelligent treatment of the bubo will depend upon a clear understanding of the nature of the lesion. In most of the cases more than one lymph node is involved. The process starts as a small focus of necrosis and abcess-formation in the central portion of the node and extends more or less steadily until the entire node is involved and finally breaks down into an abscess which extends some distance into the surrounding tissues. Frequently there are several foci of suppuration in a single lymph node. For this reason early surgical treatment by incision is likely to be disappointing, for it is impossible to say what particular nodes are involved, and consequently, unless the whole group of nodes is excised, there is no certainty of putting an end to the process. With a fuller realization of these facts has come a curbing of the enthusiasm for early incision, and the majority of surgeons are now content to palliate the process as far as may be and to wait for resolution, which occasionally takes place, or for complete breaking down of the tissue involved, when incision is likely to prove curative.

Palliative Treatment.—Palliative treatment consists in rest and counter-irritation by the application of heat or cold. In the majority of cases it is quite impossible to carry out this treatment, as nothing short of a disabling lesion will persuade the average patient, who has a bubo, of the necessity of confinement to bed. But if he can be induced to remain in bed or at least to remain quietly in the house, the more or less continuous and efficient application of cold in the form of an ice bag may, in the earlier stages of the disease, result in resolution. How commonly this might occur, we have no means of judging, as it is only in a few cases that the necessary conditions can be obtained. After the inflammatory process has once become active, heat is more comfortable and more efficient. It does not commonly induce resolution, but it hastens complete breaking down, with the formation of an abscess.

The common course of the disease is this:—The patient presents himself with a small collection of tender, enlarged lymph nodes in one or both groins. He is advised to go home and keep an ice bag continuously applied to the inflamed region. He neglects to do so, and presents himself again, at the end of three or four days, with increased evidence of active inflammation—œdema, redness of the skin, and a mass of enlarged lymph nodes. No fluctuation can be detected.

At this time—since locomotion is now as a rule difficult—it will be possible to persuade him to apply poultices in some fashion until the mass is broken down. This occurs generally during the following week and there results a more or less localized abscess, surrounded by a mass of infiltrated tissue and partially broken-down lymph nodes. At this point more radical measures are indicated.

Radical Treatment.—Radical treatment may be said to include all measures which evacuate the abscess, viz., free incision, puncture, or the complete enucleation of the nodes involved. Many surgeons have recommended injecting the mass of inflamed lymph nodes, after puncture or incision, with various antiseptic solutions, in the hope of thereby producing resolution. The method has never seemed to me to be based upon sound principles and I have no experience with its use. The fact that the infection is most active in the deeper portions of the inflamed nodes makes it improbable that any solution will reach the root of the condition.

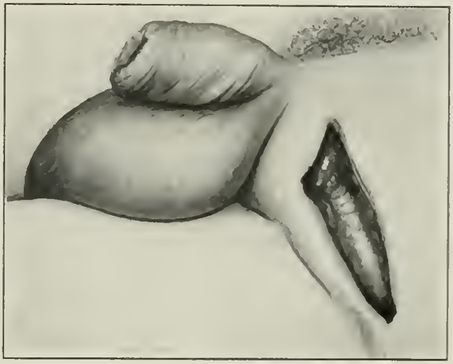


Fig. 515.—Wound Left after Enucleation of the Lymph Nodes Involved in a Bubo.

The efficiency of incision will depend in a large measure upon the completeness with which the lymph nodes have broken down. Where the process has involved a few nodes and has caused their complete destruction, incision with evacuation and drainage will effect a cure. *Per contra*, where many nodes are involved, some of them being completely broken down and others still in the earlier stages of necrosis, incision will evacuate the free pus, but will leave many foci of suppuration untouched. These will continue to grow, break down, and discharge, the process continuing for days, weeks, or even months. It is to this class of cases, with extensive involvement of the lymph nodes, that enucleation is particularly applicable. When, after the abcess has been incised, it is found that a mass of nodes still remains, it has seemed to me wiser completely to enucleate these diseased nodes, in the belief that thereby an end may be put to the process. (Fig. 515.) Where bilateral involvement exists, one should hesitate about undertaking complete enucleation. It is important not to remove nodes which may heal and retain a part of their function, since complete removal of all the inguinal lymph nodes of the transverse set has occasionally resulted in serious interference with the lymphatic supply of the genitals and in the production of a pseudo-elephantiasis. In bilateral cases more conservative measures should be adopted, although it will probably involve a greater expenditure of time on the part of the patient.

Treatment of Chancroidal Infection of the Edges of the Wound.—In some of the more virulent cases incision and drainage of these inflamed lymph nodes is followed by prompt and sometimes extensive infection of the edges of the wound by the specific organism. Thus, in a short time the edges will present a typical chancroidal appearance, and the process, if left untouched, will spread and sometimes involve extensive areas in the vicinity of the original lesion.

The treatment of this condition is essentially that of the original ulcer. As a rule, mild preparations do little good and the active use of strong antiseptics is necessary. Escharotics such as carbolic acid, alcohol, nitric acid, and the actual cautery, are, as a rule, necessary to check the process. It has seemed to me that the situation is one which is particularly suitable for the use of the actual cautery, and on several occasions I have succeeded, by the thorough use of the cautery, in abolishing ulcers which resisted other forms of treatment. The process is painful and must necessarily be carried out with the aid of a general anaesthetic. The cauterization should be thorough and all infected tissue should be deeply and efficiently destroyed. The wound may then be packed with gauze, and in a few days the slough will separate and leave a healthy granulating wound. Much of the patient's time may be saved by an early decision to treat these conditions radically, rather than to persist with mild inefficient measures.

GONORRHŒAL URETHRITIS.

By HUGH CABOT, M.D., Boston, Massachusetts.

I. ACUTE GONORRHŒAL URETHRITIS.

Etiology.—Though for many years the identity of the causative agent of this world-wide scourge has been the subject of numerous acrimonious and learned discussions, we have now happily reached the point where doubt no longer exists among scientific men. Beginning with the discovery of the gonococcus by Neisser, in 1879, and continuing with the painstaking work of Welander, Lustgarten, Mannaberg, Rovsing, Petit, Wassermann, and the more recent excellent work of Heiman and Young, the life history and the entirely specific properties of the organism have been determined beyond the shadow of a doubt. We will not, therefore, continue this discussion, but will refer those who desire a more extended knowledge of this admirable research to the original documents.

Characteristics of the Causative Agent.—The gonococcus is a D-shaped diplococcus. This description is somewhat preferable to the term "biscuit-shaped" which has been in such common use, as the latter term fails to tell us what particular variety of biscuit it is intended to describe. The organism is found in the pus cells in the discharges from infected mucous membranes, in the epithelial cells, and free in the fluid. Its arrangement within the cells is quite characteristic, though such an arrangement largely defies description and is best understood by reference to the figures. (See Figs. 516 and 517.) The organism readily takes any of the aniline dyes and, for the purpose of studying its morphology, may be conveniently stained with a saturated aqueous solution of methylene blue. With this stain the gonococci, the nuclei of the cells, and any other organisms which may be present, take a deep blue stain, while the protoplasm of the cells is very slightly stained. The technique of this method of staining is very simple and well within the reach of any practitioner who is reasonably familiar with the use of the microscope. The pus may be prepared by securing a small drop upon a cover glass, placing another glass immediately on top of it, and drawing the two rapidly apart as in the method of preparing blood films for staining. In this way a thin film is obtained. An entirely satisfactory preparation may also be made by placing a drop upon a glass slide and spreading it carefully with the edge of a piece of filter paper until it is reasonably thin. These preparations should be allowed to dry and then should be stained for about half a minute with methylene blue. If the discharge is very mucoid in character a somewhat longer staining will be necessary, and the success of this procedure may be determined by the depth of color imparted to the slide. If the color is very pale when the stain is washed off, it is wise to stain it longer before submitting it to examination. If a cover glass has been used it should be placed upon a glass slide while still wet with water, the excess of water removed with filter paper, and the upper surface of the cover glass carefully dried. It may then be examined under the oil immersion with complete satisfaction. If the glass slide has been used for the preparation it may be examined immediately after having been dried, the oil being placed directly upon the surface of the preparation. While this latter is a less workmanlike procedure, it is convenient and gives entirely satisfactory results. The value of this stain lies in the fact that it renders visible the diplococci having the characteristic grouping and intracellular arrangement of the gonococcus. It is in no sense a differential stain and will not distinguish the gonococcus from other intracellular diplococci. On the other hand, it is doubtful whether any of the other intracellular diplococci are capable by themselves of producing a clinical picture at all likely to be confused with that of an acute gonorrhœal urethritis. It is a valuable method of staining and serves to furnish the practitioner with presumptive evidence which, coupled with clinical evidence, is frequently sufficient for the diagnosis. If the whole picture leaves us in doubt, the so-called Gram stain may be employed.

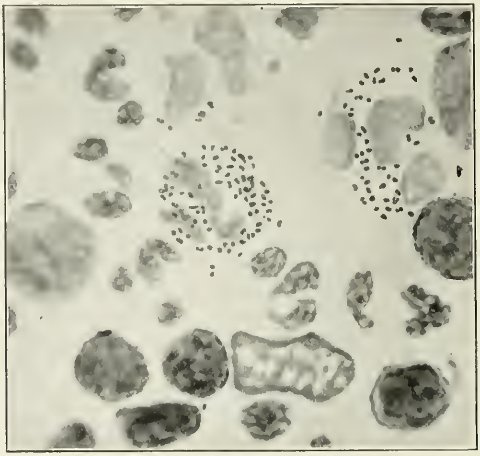


FIG. 516.—The Gonococcus in a Urethral Discharge. Photomicrograph of preparation stained with methylene blue. Note the outline of the pus cell as shown by the grouping of the cocci.

The Gram Stain.—The value of the Gram stain lies in the fact that it differentiates the gonococcus from other similar organisms, as the gonococcus does not retain the original stain after treatment with Gram's solution. In common language, it does not "take" the Gram. A satisfactory modification of Gram's original staining method is that of Chetwood. The different steps of this method are as follows:—

1. *First Stain.*—The dried film should be placed in the following solution for thirty seconds:

A saturated alcoholic solution of gentian violet	1 part.
Two-per-cent solution of carbolic acid	9 parts.

On removal from this solution the film should be placed "butter side down," in a dish of Gram solution.

2. *Second Stain.*—The Gram:

Iodine	1 part.
Potassium iodide	2 parts.
Distilled water	300 parts.

Cover glass should be allowed to remain in this solution four or five minutes.

3. *Alcohol.*—Upon removal from the Gram solution it should be placed in alcohol and washed for about half a minute, until the slide presents the white, pearly appearance seen before the stain was applied.

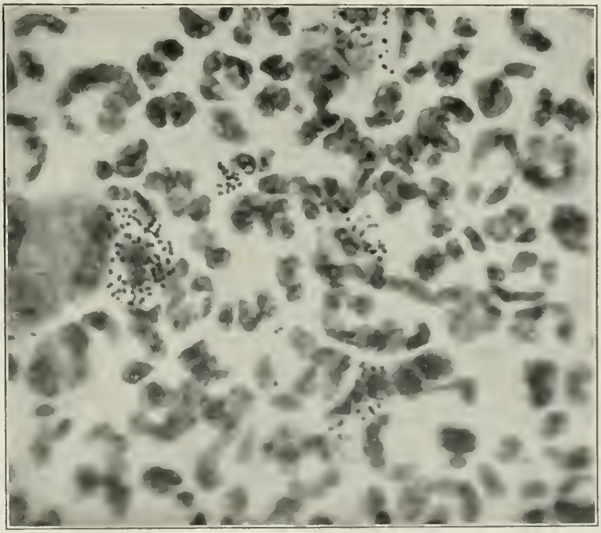


FIG. 517. The Gonococcus in a Urethral Discharge. Prepared by the same method as that employed in Fig. 516. Note the more scattered arrangement of the cocci.

4. *Water.*—The slide should now be freely washed in water which must not have been used at any previous stage of the stain.

5. *The Contrast Stain.*—In order that the gonococci, which have now been thoroughly decolorized, may be more readily seen, some contrast stain is necessary. A very satisfactory one is saturated aqueous solution of Bismarck brown. This is not a powerful stain and the slide should be left in the mixture for four or five minutes, in order to give good definition to the gonococci. The slide should now be washed with water and dried.

If intracellular diplococci other than gonococci are present, they will retain the deep purple of the original gentian violet. The gonococci, on the contrary, will appear a golden brown, and are readily distinguished.

The use of the Gram stain, while not in itself technically difficult, requires experience and judgment, as does any other bacteriological examination. It will be of value only to those who are in a position to use it with considerable frequency, and errors in technique or insufficient knowledge of the use of the microscope will completely vitiate all conclusions. It is distinctly not a method for the use of the practitioner who requires it only at long intervals and whose total experience is insufficient to give him reasonable familiarity with such methods of diagnosis. If absolute accuracy is desired (and it is surely unnecessary to say that an error in diagnosis in this disease may be of very far-reaching consequence) the slides should be submitted to an expert and his opinion alone should be taken as conclusive. For the purposes of the general practitioner the simple methylene blue stain will be quite as likely to lead to correct conclusions.

Cultures.—Even the Gram stain in the hands of an expert may not give sufficient accuracy to permit an absolute diagnosis, and under these circumstances a resort to the culture method may be necessary. The organism grows with some difficulty, on a rather special medium, and, as this examination can only be made by a bacteriologist thoroughly familiar with the cultural characteristics of the organism, the details will not be described here.

Method of Infection.—The only essential to infection is the contact of pus or mucus containing the gonococcus, with the urethral mucous membrane. No abrasion or trauma is necessary. As will appear in the section on Pathology, the organism remains free upon the surface or partially hidden in the crypts or folds of the mucous membrane for a short though variable period of time, and then, by an action rather peculiar to itself, insinuates itself into the deeper tissues. The disease is practically always venereal in origin, and, though other methods of infection, such as contact with soiled linen, towels, etc., are theoretically possible, and serve as an explanation much desired by the unwary, they cannot be accepted as at all common and are probably so rare that they may be neglected as a factor. The whole question of infection has been surrounded by considerable mystery owing to the now well-recognized difference in the liability to infection of different individuals exposed to the same danger, and of the same individuals under varying circumstances. This can be explained only upon the assumption that the gonococci in the infecting discharge vary from day to day in number and virulence. Undoubtedly, also, the resistance of the individual varies very much with his own general condition, and the same general circumstances tend to make him liable to infection with this organism as would render him receptive to other infectious processes. Alcohol seems to have a distinct effect, though it is less easy to decide in what manner it acts. It is possible, though perhaps not probable, that it lowers the general ability of the tissues to withstand infection sufficiently to be an important factor, but it is somewhat doubtful whether its action is rapid enough to produce this result, though it is well known that chronic alcoholism undoubtedly renders the individual more susceptible to general infections. It is far more probable that the danger of alcohol comes from its blunting of sensibilities and from its likelihood to lead the individual to excess and violence. In the same connection it should be noted that excesses without the influence of alcohol also increase the liability to infection.

Another factor of undoubted importance is the proximity of the menstrual period. The congestion and increased glandular secretion which take place at this time tend to increase the activity of gonococci which may for a considerable time have lain dormant and have become attenuated in virulence to such an extent as to be practically harmless. The stimulus of increased blood supply rouses them to new activity and they are expelled to the surface and mixed with the secretion. This, though a theoretical, is probably a correct explanation of an observation too common to escape notice.

Incubation of Acute Gonorrhœal Urethritis.—A well-defined period of incubation is characteristic of this disease and is often important in enabling one to distinguish it from relapses or recrudescences of a previous infection, or from those rare cases of urethritis which are due to direct irritation or infection with some other organism, the importance of which will later be discussed. It may be safely affirmed that a urethritis coming on promptly after exposure is not a fresh attack of gonorrhœa, but is either a recrudescence of an already existing process or some other infection. The duration of this period of incubation, however, varies within very considerable limits and it is, to say the least, difficult to decide exactly upon what cases we shall rely in estimating the true duration. Reported cases in which the author conscientiously believes that he knows the facts beyond reasonable doubt, give a period varying from two to fourteen days. Experimental work lends color to the belief that in massive infections evidence of the disease may be present as early as the second day, but certainly in the great majority of cases no evidence is to be detected at this period, and many of them will ultimately prove to be recurrent and not fresh infections. In most cases the evidence of infection will not be found before the third day. In an interesting series of cases collected by Keyes, the average incubation period of thirty-four primary infections was six days, with scattered cases occurring on the eighth, ninth, tenth, eleventh, twelfth, and thirteenth days. This has been the experience of other equally careful observers, and evidence of the credibility of cases showing an incubation period of more than ten days should be carefully scrutinized. The whole matter is much complicated by the well-known inability of patients with this disease to distinguish between truth and falsehood, and we shall probably do them no great injustice by believing that the explanation of these unusual cases is the old one, namely, that "the boy lied." In general, the incubation period varies from three to ten days in fresh infections, and the great majority will be found upon the fourth, fifth, and sixth days. That the variation is thus large is probably due to the same conditions which influence infection, namely, the virulence of the organism and the relative resistance or lack of resistance of the tissues.

Pathological Anatomy.—The successful treatment of urethral inflammation is so dependent upon a thorough understanding of the pathology that it seems necessary to review certain points even in a work of this kind, which is intended to be largely clinical.

The anterior urethra is lined with columnar epithelium, except in the fossa navicularis, where its surface is covered with squamous epithelium. Under this epithelial layer is a basement membrane of connective tissue, very rich in elastic fibres, to permit the ready distention of the urethral canal. This basement membrane is surrounded by a very thin layer of unstriped muscular fibres, and the whole is in turn enveloped in the corpus spongiosum.

The various depressions and openings in the mucous membrane are important factors in explaining the course of the disease.

Throughout the anterior urethra are found depressions or crypts which appear to be simple inversions of the mucous membrane. The largest of these, the lacuna magna, is situated upon the roof at the posterior extremity of the fossa navicularis. Others are scattered along the canal, chiefly on the roof, but occasionally along the floor.

Of the glands of the urethra, the most important are those of Littré. They are compound racemose glands which penetrate the mucous membrane, pass through the muscular layer, and the deeper portions of some of them lie in the substance of the corpus spongiosum, a fact which is important in the etiology of chronic urethral inflammations and particularly in the causation of organic stricture. The ducts of these glands are rather narrow and point forward except in the bulbous portion, where they enter the urethra at right angles to its axis. They are found in greatest numbers along the roof of the canal and their number increases in the deeper portions of the anterior urethra. Their secretion is a viscid, alkaline substance, whose function is apparently to lubricate the canal. Besides the glands of Littré, the mucous membrane is studded with mucous crypts or glands quite similar to those occurring in other mucous membranes and exercising a similar function.

It will thus be seen that what with lacunæ, crypts, and glands of one kind or another, the canal is well supplied with caves and hiding-places which can conceal the gonococcus and which may readily entrap the unwary practitioner who believes that active treatment applied to the surface must promptly reach the offending organism. Our knowledge of the early pathology of urethral infections is largely derived from the work of Finger, Gohn, and Schlagenhaufer, who were fortunately in a position to watch the progress of infection in various early stages. At the end of thirty-eight hours evidences of activity were readily to be found: the lacunæ were filled with gonococci; the leucocytes had begun to gather at the scene of action; and cocci were found already inside the cells. At the end of three days inflammatory reaction was well marked; the cocci had penetrated between the cells and had taken a sharp hold upon the epithelium. The cylindrical epithelium of the anterior urethra was generally invaded, the process being most active about the crypts and glands, which were fairly stuffed with cocci. The pavement or squamous epithelium appeared to have resisted invasion, but the subepithelial connective tissue showed evidences of cellular infiltration, and in the neighborhood of the glands the cocci had in some places penetrated into this layer. By the magnificent work of these investigators it was made clear that the most active and most dangerous part of the inflammation takes place in and about the crypts and glands, and that the squamous epithelium is markedly more resistant than the columnar.

Acute Anterior Gonorrhœal Urethritis.

SIGNS AND SYMPTOMS.—It is usual to describe a prodromal stage, during which the first signs of irritation in the urethra appear. This is, however, nothing more than the beginning of a catarrhal process which goes on quite steadily in its development, and no sharp separation can be made into a prodromal stage and a stage of efflorescence, as has occasionally been done. The earliest symptoms, which make their appearance three or more days after infection, are: slight itching or tickling in the urethra, particularly in the region of the fossa navicularis; a very slight smarting on urinating and a little sticky or gummy discharge, which is more or less noticeable according to the time which elapses between urinations. Once these symptoms have appeared there is no halt in the forward march of the disease. During the succeeding days the discharge increases, becomes muco-purulent and purulent, the itching changes to a distinct burning, and evidences of inflammation appear at the meatus and along the urethra. At first, this amounts only to a pouting or eversion of the meatus itself, which goes on to a more or less marked swelling of the whole glans, and is generally accompanied by some œdema of the prepuce. The pendulous portion of the urethra may be felt as a thickened, somewhat tender cord along the inferior surface, and, as time goes on, this thickening and tenderness become very noticeable and a slightly nodular condition may develop as the result of infiltration around the mucous follicles and glands of Littré. In well-developed cases the lymphatics, particularly along the dorsum, may be felt as hard, tender cords, and their position is not infrequently marked by red streaks on the skin. Frequently the inguinal lymph nodes show involvement at this time—that is to say, toward the end of the first, and during the second, week they become enlarged, hot, and tender. But the process is a benign one, which subsides rapidly and does not go on to pus-formation, thus distinguishing this type of lymphatic infection from the slowly developing, hard, indolent lymph nodes of the primary lesion of syphilis, on the one hand, and the more active and very commonly suppurating nodes of a chancroidal infection, on the other.

If the disease is allowed to proceed unchecked, the discharge rapidly increases in amount until the pus fairly runs from the urethra. Its character changes from the muco-purulent secretion of the first few days to a yellowish or greenish pus, which in the severer cases may be streaked with blood. At this time the discomfort accompanying the passage of urine has become real pain; the swelling of the mucous membrane to some extent narrows the canal; and this, coupled with the pain, makes the stream of urine small and occasionally hesitating.

While the disease in its typical form is now confined to the anterior urethra.

the congestion and increased blood-supply which accompany it have a very noticeable effect upon the deeper portions of the canal. Thus, when the disease is fully developed the tendency to frequent erections is very marked, particularly at night, when it may be so troublesome as to deprive the patient of sleep. It is, moreover, a condition distinctly unfavorable to the smooth progress of the disease, as the distention of the cavernous tissue stretches the urethra, already stiffened by infiltration, not infrequently produces small cracks or fissures through which increased infection may take place, and renders the deeper tissues, particularly the elastic structures of the corpus spongiosum, more accessible to the penetrating organism. It is the combination of these two elements—namely, the uncontrollable tendency to erection and the infiltration and stiffening of the corpus spongiosum—which results in that not very common symptom which is designated as "true chordee." This term has been so much abused that it is frequently regarded as synonymous with painful erection: but, while it bears some relation to the latter symptom, it is by no means so frequent. In chordee the organ is sharply bent forward, owing to the loss of elasticity and distensibility of the damaged corpus spongiosum, which, being unable to follow the distention of the corpora cavernosa, forms the string to the bow of which the corpora cavernosa are the shaft. During the earlier part of the disease, particularly during the stage of active development, moderate constitutional symptoms are not uncommon. Thus, mild degrees of fever, in which the temperature occasionally rises above 100° F., general malaise, lassitude and loss of appetite, are not infrequently observed. The course of the disease, if uninfluenced by treatment, may be roughly outlined, but it is so complicated by the frequent implication of other portions of the genito-urinary apparatus that such typical cases are rarely seen. The severity of the attack will continue to increase more or less steadily for about two weeks, when it may have reached its acme, and may remain quite stationary during the third and part of the fourth week. The stage of decline will then begin, during which there is a steady retrogression of all the symptoms: inflammation, particularly in the surrounding structures, will diminish: pain on urination will disappear; the discharge will diminish in amount and become more mucoid. By the end of the fifth or beginning of the sixth week, it may amount only to a symptomless muco-purulent discharge from the urethra. If all goes well this will continue to diminish, become purely mucoid, return to the slight tendency to gluing of the meatus seen during the first few days, and finally disappear entirely. In favorable cases the disease may run its whole course in six weeks and it is likely that an attack of moderate severity, in a previously healthy urethra, will generally run its course, if free from complications, in two months. Considered in this way, the disease may be regarded as a self-limited one, but the occurrence of some complication, such as an extension to the posterior urethra, is so common as to make so favorable a course as that just described, not at all to be expected.

APPEARANCES OF THE URINE.—As the appearance of the urine is in many ways our best guide to the condition of the urethra, its various characteristics should be well understood. During the stage of development the urine will show only a few shreds, which at this time may be indistinguishable from those seen in a chronic urethritis. With the development of the disease, however, this promptly changes to a turbid condition of the first portion of the urine. If at this time the urine is passed into two glasses, that in the first will be more or less turbid, according to the development of the disease, while that in the second will be clear. If the discharge is very profuse and the urine is divided into small portions because the patient has recently emptied his bladder, there may be some turbidity of the second portion—a possible source of confusion. For this reason, when the discharge is profuse it is wise to insist that a fairly large amount be passed into the first glass—generally, that the glass be filled. This will render it possible to make an early diagnosis of posterior urethritis, should any clouding of the second portion, other than that due to phosphates, occur.

Acute Posterior Gonorrhœal Urethritis.

The very intimate relations existing between a posterior urethritis and an anterior urethritis, make it logical to consider it here. In fact, it is hardly possible to discuss the future of an anterior inflammation unless the presence or absence of a posterior urethritis be known, as it is so common, and also influences the outlook so profoundly, as almost to constitute the sole ground upon which a prognosis can be made. Involvement of the posterior urethra is important not only in itself, but as constituting the first step in a long series of other complications which further cloud the outlook. Thus, prostatitis, acute or chronic, seminal vesiculitis, and epididymitis, follow only upon the occurrence of inflammation of the posterior urethra, though it is true that in many cases the presence of posterior involvement may not have been known until these troubles manifested themselves. It remains, nevertheless, a fact that these complications must be preceded by inflammation of the posterior urethra. The frequency with which posterior involvement follows anterior inflammation has been variously estimated at from fifty-five per cent to over ninety per cent, and the discrepancy is apparently due in part to the difference between the methods of diagnosis practised by various observers, and in part, doubtless, to the class of patients with which they had to deal. Thus, Finger observed that posterior urethritis occurred in sixty-three per cent of his private patients and in eighty-two per cent of those seen in his hospital clinic. The general tendency of modern opinion seems to be in the direction of regarding its frequency as greater than had been previously supposed, and, taking all classes of cases together and considering all grades of severity of the disease, we may fairly expect to see it in seventy-five per cent of the cases. Its occurrence is influenced by the following factors:—

1. The severity of the anterior infection, in so far as the same factors which tend to make the infection severe also increase the probability of its extension backward.

2. The social status and surroundings of the patient are important, as, among the poorer and more ignorant classes, neglect of precautions in treatment and inability to alter the character of their work increase the probability of further trouble.

3. Perhaps the most important factor is the previous existence of inflammation of the posterior urethra. In these cases future infections are nearly certain to involve promptly the deeper portions of the canal, and indeed this posterior involvement may be the first evidence of a fresh infection.

4. Treatment is also a weighty factor. The normally closed condition of the membranous urethra offers a barrier of some importance, which, under normal circumstances, inhibits posterior involvement. If this natural barrier be interfered with by treatment, whether with instruments or with injections, extension is made more easy. Great stress is laid by Finger upon the use of ill-fitting suspensories, which cause undue pressure either at the peno-scrotal angle or in the region of the bulb, thereby preventing the natural discharge of pus from the anterior urethra and favoring its discharge backward through the cut-off muscle. It may be that the construction of suspensories is less faulty in this country, or that they are less frequently worn, but this has not seemed to me to be a very important factor in the production of posterior complications.

Clinical Pathology.—It is but reasonable to suppose that in most anterior infections involving the bulbous portion of the canal, some infection of the membranous portion takes place; and that this does not go on to real involvement of the whole deep urethra is probably due to the fact that it is violently flushed by the stream of urine. The prostatic urethra, on the other hand, by reason of its numerous glands and crypts, offers a most favorable soil for infection and for the permanent abode of the infective organism, and we find, as would be expected, that it is here that the gonococcus readily finds lodgment, and from here that it is dislodged with the greatest difficulty. It is customary to speak of a posterior urethritis as if it were pathologically different from a prostatitis, and clinically this appears to be the case, but in reality no proper distinction can be drawn between a posterior urethritis and a prostatitis, the former differing from the latter only in degree. Clinically, the distinction is a convenient one as a basis for treatment, but it is well to bear in mind the fact that it has no solid pathological foundation. In passing, it may be noted that the relative immunity of the mucous membrane of the bladder in the vicinity of the internal orifice of the urethra, is probably due to the same conditions which influence the membranous portion.

Symptoms.—Those who expect the occurrence of posterior inflammation to be heralded by severe, or even always noticeable symptoms, are doomed to disappointment. In a very considerable proportion of the cases it takes place without symptoms, and is to be detected only by careful examination of the urine or by the irrigation test later to be described. It is difficult to say upon what this immunity to symptoms depends, but it is probably at least influenced by the rapidity with which the extension takes place, the activity of the local process, and the depth to which the tissues are involved. In many, perhaps even in most of the cases in which the inflammation occurs as a complication of an acute anterior process, the first symptoms noted are slight frequency or urgency of urination; and cases are frequently seen in which, although the patient may empty the bladder at normal intervals, when the desire to urinate once appears, he has little ability to control it and it becomes really imperative. As the symptoms increase in severity there is pain, particularly as the last drops of urine leave the bladder and the prostate contracts to expel them. With this comes a feeling of fulness and weight in the perineum, with shooting pains about the neck of the bladder. At times there may be marked irritability of the sexual apparatus, and the frequent occurrence of seminal emissions, particularly during the third or fourth week of an anterior infection, points with considerable certainty to deep involvement in the region of the caput gallinaginis. In the more severely acute cases the symptoms may be ushered in with a chill, an intense desire to urinate, great frequency of urination, burning pain which is not relieved when the bladder is empty, and marked constitutional symptoms. These severe symptoms are due to involvement of the deeper portions of the prostate.

With the onset of posterior urethritis the amount of discharge from the anterior urethra at once diminishes, and if the onset of symptoms is slow this may lead the unwary to the vain hope that a rapid improvement is taking place. Nothing is more illusory, as it may be confidently expected that, with the subsidence of the inflammation in the deeper portions, the discharge from the anterior urethra will again appear.

Diagnosis.—We shall consider here only the diagnosis of acute urethral infections, reserving until a later time the more difficult discussion of the question involved in chronic processes.

Given an acute inflammation of the urethra, there are two chief questions which must be answered:—

1st. Is the infection due to the gonococcus?

2d. How much of the mucous membrane of the urethra has it involved—that is to say, is there posterior infection?

If the case presented is one of acute florid urethritis, we have three possibilities to consider:—

(1) An acute fresh infection with the gonococcus; (2) An acute recurrence or recrudescence of a previous infection, sometimes spoken of in medical slang as a "flare-up"; (3) Some other infection or an acute chemical irritation.

Acute gonorrhœal urethritis differs from all other infections in that it comes on only after a well-defined period of incubation, that it is accompanied by evidences of inflammation—certainly recognizable in the region of the meatus and generally involving other adjacent tissues,—and that the discharge inevitably contains gonococci. An acute "flare-up" may show the gonococcus, but will lack the period of incubation and will frequently exist without, or with but very slight, evidence of inflammation outside of the urethra. The doubtful cases are those in which exposure to possible sources of infection has been so constant as to make it impossible to decide whether a period of incubation has or has not existed. Under these circumstances we get considerable aid in diagnosis from the course of the disease. Acute fresh infections come on slowly and progress steadily to their acme, which is reached only after a considerable time. They then subside, also slowly, but much more surely than recurrent processes. Acute recurrences, on the other hand, reach their acme quickly and as a rule subside promptly, but show a well-marked tendency to become chronic. In some cases, particularly those with "a urethral past," the history may be so unreliable, the course of the disease so little typical either of an acute infection or of a recurrence, and the whole picture so confused, that a positive diagnosis between the two conditions is impossible.

The distinction between these two processes and an acute infection with some other organism, or some very acute irritation, is as a rule easy. Were it not for the testimony of observers of such well-known merit as Finger and Keyes, we might almost be at liberty to doubt the existence of infections sufficiently acute to simulate seriously an acute gonorrhœal urethritis. Certainly such cases are of great rarity and we shall but rarely be called upon to deal with them. They are said to come from infection by a menstrual or leucorrhœal discharge; but I frankly confess that I doubt the possibility of these conditions producing an acute infection in a healthy urethra, and I incline to the view that they can have such an effect only upon a urethra previously, and probably permanently, damaged by infection. When they occur they may always be distinguished from an acute fresh infection by the lack of a period of incubation and by the absence of the gonococcus, and from an acute recrudescence by the latter sign. They occur promptly after contact with the exciting irritant, quickly reach their acme, and rapidly subside, frequently without treatment.

In cases in which there is but little discharge the diagnosis may be much more troublesome, but we have to consider here only those cases which represent the beginning of an acute fresh infection, one which presents itself before it has gained a strong foothold upon the urethra. In these cases the number of gonococci will probably be large in proportion to the amount of discharge, and their detection correspondingly easy. Furthermore, within the next day or two a fresh infection will have clearly declared itself and the diagnosis can then be made with ease.

In identifying the gonococcus in doubtful discharges it should be made to pass muster by various tests, of which the following are the important ones:—

Form and Arrangement of the Gonococcus.—In a well-stained specimen the form and arrangement of the organism within the cells is quite characteristic and will generally distinguish it from other intracellular organisms.

Staining Reactions.—In doubtful cases both the methylene blue and the Gram stain should be used, always with the proviso that the observer is sufficiently familiar with them to make his opinion of value.

Number of Organisms.—In positive cases the number of intracellular peculiarly-grouped organisms is generally considerable, and, where only a few diplococci are discovered in the examination of several slides, the case must be regarded as extremely doubtful, and the matter is then best referred to an expert.

Finally, if the foregoing tests leave us in serious doubt, cultures should be employed, but only by one thoroughly familiar with the peculiarities of the gonococcus.

How much of the mucous membrane of the urethra has the inflammation involved? This question is of the first importance in planning treatment, and in answering the question in which the patient is always most interested—viz., as to the probable duration of the process. The "two-glass test" is here of much value. The patient should be instructed to pass his water into two glasses, the first portion being sufficient to fill an ordinary urine glass. If both urines are cloudy from the presence of pus, there is posterior inflammation. It is proper here to caution the unwary against mistaking a urine cloudy with phosphates for one cloudy with pus. The distinction will readily be made by adding a few drops of a strong acid, preferably acetic acid, when the phosphates will promptly disappear. If the second urine be clear, the process is likely to be confined to the anterior urethra, but a clear urine is frequently seen in cases of mild posterior infection. The reason for this will readily be seen if we consider the mechanism by which the second urine becomes turbid. The tonicity of the cut-off muscle is sufficient to prevent the secretion of the posterior urethra from running forward and escaping from the urethra. Under these circumstances, if it is at all large in amount, it inevitably runs backward, mixes with the bladder urine, and produces a cloudiness of the whole amount proportionate to the severity of the posterior process. If, however, the amount of secretion in the posterior urethra is small, it may remain upon the surface and be washed out with the stream of urine in such a way as to show entirely in the first portion. An ingenious method of distinguishing this has been suggested by Finger. It is based upon the fact that during the long interval which normally elapses during the night, when the bladder is not emptied, the secretion of the posterior urethra, if any considerable amount of inflammation exists, will be sufficient to overflow to some extent into the bladder. Thus, the first urine passed in the morning will show a clouding of the second portion, while that passed during the day may show the second urine clear. This is a test of some value.

If the employment of the foregoing tests still leaves us in doubt, we may make use of the so-called irrigation test. This consists in washing out the anterior urethra as far as the cut-off muscle with some indifferent solution before the patient has passed his urine. If this has been efficiently done, any pus found in the urine passed after irrigation must come from the posterior urethra. The test is best carried out by introducing a small soft-rubber catheter gently as far as the region of the bulb and then washing cautiously but thoroughly with a good-sized hand syringe. The possible sources of fallacy in the test are:—1st. It is difficult to wash the anterior urethra absolutely clean and some few shreds may remain to cloud the urine. 2d. It is possible, in some cases where the tonicity of the cut-off muscle is slight, to wash some of the shreds from the anterior urethra back into the bladder.

This test is made more accurate by the use of some solution which will color the shreds in the anterior urethra even if it does not completely remove them: and for this purpose a mild solution of potassium permanganate or, perhaps better, zinc permanganate, may be used. The shreds remaining in the anterior urethra will then be colored brown and may be distinguished from those coming from behind the cut-off muscle.

With the limitations above noticed, these tests will enable us in the great majority of instances to decide whether the disease has or has not involved the posterior urethra, and the amount of pus will give us a fair indication of the probable severity of the deep inflammation.

PROGNOSIS.—The prognosis of acute urethritis is entirely good so far as life is concerned, though, as medical curiosities, cases of death have been reported from acute general infection occurring in individuals of much lowered vitality. The important question in prognosis, however, is as to the probable duration of the disease, and this is principally influenced by three factors:—1. Number of the infection—that is to say, whether or not it is a first attack; 2. The occurrence of complications; 3. The general condition of the patient. The number of the attack is a very important factor in prognosis. Thus, first attacks go on to complete recovery in the majority of cases. Second attacks recover more slowly and somewhat less surely. Third and subsequent attacks show a very marked tendency to become chronic, and it is in this class that we see the so-called incurable cases.

The duration of any particular attack is dependent largely upon the occurrence of complications. An uncomplicated acute anterior urethritis nearly always recovers after the lapse of a reasonable length of time, and the prognosis, therefore, becomes, for practical purposes, the prognosis of the complications, which will be considered more in detail later.

The general condition of the patient is here, as in other acute infections, a factor always to be reckoned with. Poorly nourished, cachectic individuals, or those having some other chronic disease such as tuberculosis, recover much more slowly than their more healthy brethren, and the urethral disease shows a distinctly greater tendency to become chronic. In attempting to state the probable duration in any given case, conservatism is the part of wisdom. An acute uncomplicated first infection may run its course in six weeks and end in complete recovery. The average time, however, is not much less than two months, and the occurrence of complications may double or triple this period. It is, therefore, wise frankly to state to the patient the conditions governing speedy cure and not to lead him to expect recovery in less than two months.

TREATMENT.—*General Measures.*—Under this heading will be considered the questions of hygiene, diet and general medicinal treatment, as opposed to the purely local treatment of the diseased mucous membrane.

Anything which tends to improve the patient's general condition will have a favorable influence upon the course of the disease, and this fact should be duly impressed upon him. I am in the habit of advising my patients that they should treat themselves as an athlete in training, and that they should order their lives to conform to this standard,—this, of course, with certain reservations in regard to diet and exercise; but the simile has seemed to me a valuable one, and has worked well in practice.

Exercise.—It is undoubtedly true that confinement to bed would generally lead to the most rapid recovery, but this is not practicable and cannot be insisted upon except in the presence of certain complications. It is, however, proper to insist that all violent exercise should be avoided. This particularly applies to riding, either on a horse or on a bicycle, and even to driving over rough roads. Walking in moderation is the only safe exercise for these patients. The French and German schools are very insistent upon the use of some form of suspensory bandage, and it is doubtless of some value, but its use is annoying to many patients, and I am by no means clear that failure to insist upon the practice is followed by bad results.

Diet.—The diet should be simple, with plenty of liquids. Intestinal irritants should be avoided and the digestion should not be taxed. Highly spiced and seasoned food, very salt or acid foods, should be avoided. It has long been customary to insist that white meat and fish are less objectionable than red meat, but I have never been able to satisfy myself that the color of the meat is of essential importance.

Drinks.—Alcohol in all forms is objectionable and its strict avoidance should be strongly urged. The German school has found this practically impossible, and is in the habit of allowing light red wine. In this country it is generally possible to persuade the patient to avoid alcohol entirely, and this course should therefore be insisted upon. Ginger ale is nearly as objectionable. Effervescent mineral waters do distinct harm. Many surgeons forbid the use of coffee, but the evidence of its undesirable effect is very doubtful and it may be allowed in moderation. Undoubtedly the best beverages for these patients are milk and water, tea and coffee, in moderation.

Smoking.—Although, as in the case of coffee, many surgeons forbid the use of tobacco, the point does not seem to be well taken, and, as we have already deprived the patient of many things which are important to his comfort, it does not seem wise to forbid smoking except for the very best of reasons.

Drugs.

The drugs which are of value in the treatment of acute urethral inflammations may be classified under four heads: Antiseptics, Alkalies, Anodynes, and Balsamics.

Antiseptics.—Contrary to what might be reasonably expected, the so-called urinary antiseptics have little or no value in the treatment of inflammation of the urethra. Because of their great usefulness in inflammatory processes of the bladder and upper urinary tract they have been given an extended trial and are still used to some extent, but evidence of their value is strikingly lacking. The ones most commonly used are: the formaldehyde group, of which urotropin is the standard; salol; methylene blue; and boric acid or the borates. The formaldehydes seem to be entirely worthless. Salol is valuable in combating the intestinal irritations not infrequently associated with the use of the balsams, but has no apparent effect upon the urethral condition. Methylene blue, at one time much vaunted, appears to have its sole effect upon the imagination of the patient, and, unless the surgeon has confidence in the results of suggestive therapeutics, its use is not to be advised. Boric acid and the borates are at times useful in correcting undue alkalinity of the urine, but this is generally due to inflammation in the bladder, and the effect of these drugs is therefore upon the upper rather than the lower part of the urinary tract.

Alkalies.—Alkalies have a distinct place in the treatment of these cases, but their value depends solely upon their power to influence the reaction of the urine, and they are indicated only when it is desirable to alter this condition. Thus, to give alkalies when the urine is alkaline or neutral is a therapeutic absurdity, as their value consists in relieving the irritation due to the contact of an acid urine with an inflamed mucous membrane. At the same time their diuretic value may be taken advantage of. In general, their value may be said to lie in the treatment of those cases in which the urine is moderately or strongly acid, particularly during the acute stages. After the irritation has subsided they are unnecessary except as diuretics.

The following alkaline preparations are those in most common use:—Sweet spirits of nitre and liquor potassii. Of these two preparations the first is most useful for its anodyne effect and is therefore particularly valuable during the most acute stages. It is a less active alkali than others of the group and has less marked diuretic action. The liquor potassii, potassium citrate, and potassium acetate are commonly classified together on account of the similarity of their action. Of these, the liquor potassii is the most anodyne and therefore most valuable in the acute stages. The citrate is the most active alkali and generally the most agreeable, and is particularly valuable for the correction of hyperacidity. The acetate is a most active diuretic, though a valuable alkali, and may be relied upon to produce free diuresis. The dose of these three drugs varies from five to fifteen minims of the saturated solution and should be given with plenty of water, about three times a day. The very marked hygroscopic properties of the acetate make it practically impossible to prescribe it in powders and when this form of the remedy is desired the citrate must be used.

Anodynes.—These are required for the control of the pain during urination in the early stages and particularly for the diminution of the tendency to painful erections. Though perhaps not strictly coming under this heading, hot water is a very efficient remedy. Thus, the excruciating pain which occasionally accompanies the passage of an acid urine in the early stages, is much mitigated if the urine is passed into a vessel containing hot water in which the penis is immersed. Hot hip baths at a temperature of 104° to 110° F. are of value in reducing congestion and will often successfully combat the tendency to chordee. They should not be of longer duration than about five minutes and may be employed every few hours in severe cases.

Potassium bromide is a favorite drug for this purpose and is frequently successful, but to be effective it must be used in considerable doses, taken during the evening and early part of the night.

The tincture of hyoscyamus is occasionally valuable and is frequently given as a constituent of various prescriptions containing the balsams. It is, however, an uncertain drug and its action is not to be counted on.

In severe cases, particularly where there are frequency of micturition and inflammation about the neck of the bladder, opium is by far the most useful drug.

It alone successfully controls spasm about the neck of the bladder and mitigates the frequency of urination, which is *per se* harmful by constantly stirring up the inflamed tissues and also (through the agency of the accompanying spasm) by driving the infectious agent into the deeper parts. It is always permissible to push opium until it produces the effect of mitigating spasm. It may be used either in the form of a suppository containing powdered opium, with or without belladonna, or in that of morphine, if a more rapid action is desired. The use of opiates, however, should always be accompanied by the giving of a cathartic.

Balsamics.—Abundant clinical evidence leaves no doubt as to the value of balsams in the treatment of urethral inflammations, though the exact manner of their action is doubtful. Experimental evidence tends to show that their actual bactericidal power is small, though it is a matter of common knowledge that the urine of patients taking sandal oil will resist decomposition for days. They act by virtue of the fact that they are excreted in the urine and are thus brought in contact with the mucous membrane of the urethra. Their value is entirely dependent upon their being well borne, and this in some measure limits their usefulness. Thus, a patient who cannot take the oil of sandalwood without experiencing severe pain in the back, or one in whom the use of copaiba is promptly followed by an erythematous eruption, is obviously not likely to be benefited by the use of these drugs and it is unwise to push them in cases in which they are uncongenial to the digestive tract. With these limitations, they are valuable in all inflammatory conditions in this region, though they work much more promptly in some cases than in others.

The most generally useful balsamics are the following:—Sandalwood oil, copaiba, and cubebs. The oil made from the yellow sandalwood is generally to be preferred to that made from the red. It causes pain in the lumbar region in a certain number of cases, and in others it produces nausea, and if continued will produce intestinal irritation of some severity. It is generally best borne when given in capsules, in doses varying from five to fifteen minims three times a day. The oil is expensive and is frequently adulterated, so that it is of the first importance to be sure that the patient gets a thoroughly reliable product. It may also be given in liquid form, as in the following prescription:

℞ Pot. citrat . . . . ʒ ij.
Ol. sanitol. . . . . . ʒ iv.
Syr. acaciæ . . . . ℥ i.
Aquæ menth. pip. . . . . ad fl ℥ iij.
Sig. A teaspoonful in a wineglassful of water after meals.

The oleoresin of copaiba is, next to sandal oil, the most valuable of the balsams. It is less expensive and therefore more suited to the poorer class of patients. It is nauseating and has a marked tendency to produce a peculiar rash, spoken of as "the copaiba rash" or "erythema." This is of the urticarial type, consisting of large, slightly elevated, bluish blotches scattered over the trunk and extremities, and associated with marked itching. The rash generally follows promptly after the administration of the drug and will disappear equally promptly upon its withdrawal and the administration of a saline cathartic. This uncomfortable peculiarity may considerably limit the value of the drug. It may be given in the same way as sandal oil, but has been more commonly used in various mixtures, probably on account of its relative cheapness.

The oleoresin of cubebs is a balsam having an action similar to that of sandal oil and copaiba, but also having a distinct stimulating action upon the mucous membrane. It is, therefore, more valuable in the later stages, when a stimulant is required. It is somewhat less nauseating than the foregoing, but occasionally produces irritability of the neck of the bladder.

Tonics. The administration of tonics is often useful, particularly in the later stages, and for patients who have been pulled down by the disease. In fact, there are some cases in which tonics, a full diet, and a vacation are more valuable than any amount of local treatment. The surgeon should watch carefully the general condition of his patient and have recourse to tonic treatment whenever it seems likely to improve matters.

General Remarks in Regard to the Local Treatment of Acute Urethritis.—In spite of much opposition and disagreement, the belief in the value of local treatment has steadily gained ground until it is to-day generally accepted as the most valuable method in the great majority of cases. While it has perhaps failed to achieve all the success which has been claimed for it, there can be no doubt that it stops the discharge and makes the patient more comfortable, not only in this respect but also by preventing many of the inflammatory symptoms which are otherwise so annoying. In many cases it shortens the duration of the disease; but this by no means always follows and is not the chief reason for advocating its use. It has been objected that it increases the danger of complications, but this is probably not true when the method is skilfully used, and the blame for this fact, if such it be, must rest upon the lack of understanding of the method rather than upon the method itself. It is far more certain to be successful when employed by the surgeon himself, and when it is entrusted to the patient this step must be taken with a clear appreciation of the fact that it will give less good results and that, if the patient is more than ordinarily clumsy, complications may be expected to follow. Local treatment should be sharply limited to those cases in which it is possible to carry it out in all its necessary details. Its value as an occasional measure is extremely doubtful and is frequently unsatisfactory when employed for dispensary patients or others of equally shiftless habits. To be successful it must be employed regularly, systematically, and skilfully. It is a treatment which involves considerable expense to the patient, both in time and in money. With these limitations it is the most valuable method of treatment which we have to-day.

Abortive Treatment of Acute Anterior Urethritis.—The so-called abortive treatment is based upon the hope that the bacteria may be destroyed at one fell swoop, but, when we consider the nature of the infection and the tendency of the organisms promptly to seek the deeper layers, little can reasonably be expected in the way of really jugulating the disease.

The methods most commonly employed involve the use of antiseptics so strong that they are expected to destroy all bacteria upon the surface and also the surface epithelium, thereby reaching some of the organisms in the deeper layers. For this purpose strong solutions of silver nitrate (from one-half to two per cent) are used. Their action is to produce a violent local inflammation, by which it is possible that some of the organisms may be destroyed, and that the reaction of the tissues may be sufficient to drive the remainder to the surface, where they can be more readily reached. The method has found but little favor as it substitutes one inflammation for another, does damage, sometimes permanent, to the mucous membrane, and generally fails to abort the disease. In the very early stages of the disease before the discharge has lost its mucoid character, the use of less irritating solutions, such as protargol (five per cent) or argyrol (twenty per cent), injected at intervals of three or four hours, may succeed in so shortening the course of the disease that the term "abortive treatment" may be justifiable, but this is in fact but little more than the logical application of local treatment to a slight degree of inflammation in an early stage. We are probably justified in assuming that real abortion of the disease does not occur, and that at best the disease is but rapidly controlled.

The more rational method is to treat the mucous membrane with solutions of a strength graduated to the severity of the inflammation, the object to be attained being that of destroying or inhibiting the activity of the organisms within reach without increasing the already present irritation. The only methods which need serious discussion are the injection method and the irrigation method.

Treatment of Acute Urethritis by Injections.—The treatment by injections is based upon the hope that antiseptics, in a strength which can be borne by the tissues, will destroy the organisms on the surface and, by frequent repetition, will aid the tissues in shaking off the deeper infection. It has yet to be shown that any solution at our command can actually reach the organisms situated in the deeper glandular structures or in the periglandular connective tissue. A large number of organic salts of silver have been brought forward for this purpose, but at the present time two alone have stood the test—argyrol and protargol. Of these, argyrol is remarkably unirritating to the surface and may be used in much stronger solution than any of the other salts. It appears to have active antiseptic properties, and this, coupled with its mildness, is its chief claim to favor. Protargol is probably a more active antiseptic, but it is decidedly irritating and appears to be chiefly valuable in mild inflammations or in the later stages of the acuter infections.

Method of Using Antiseptic Injections.—To be effective, any antiseptic solution should be injected into a relatively clean urethra. For this reason the patient should always be required to empty his bladder, and this will wash the mucous membrane sufficiently clean of pus and mucus. If, however, the patient is unable to urinate, the anterior urethra should be irrigated with some bland fluid—as, for example, sterile water, salt solution, or a one-per-cent boric-acid solution. This irrigation is performed by the method later to be described. Many surgeons prefer to make the injection with the patient standing or leaning against a table, but it has seemed to me that the patient is more comfortable in the recumbent posture and that muscular contractions are thereby avoided. Either method is, however, efficient. The injection should be made with a small, blunt-pointed syringe, holding not more than four drachms. The penis is put upon the stretch, the nozzle of the syringe snugly applied to the meatus, and the fluid slowly injected until the urethra is reasonably well filled. It is desirable to avoid overfilling the urethra, as it is likely to start up muscular contractions which will force the solution backward past the cut-off muscle and thus tend to extend the infection. In some cases it will be found that the tonicity of that sphincter is very slight and that hardly an appreciable amount of force is necessary to overcome its resistance. Under these circumstances the first injection should be of small amount, not filling the urethra. This will be sufficient to produce some spasm of the cut-off, and the next injection may be made to fill the urethra. As the value of antiseptics lies largely in their being in contact with the mucous membrane for a considerable period of time, the argyrol injection should be held in the urethra for from five to fifteen minutes, according to the severity of the infection, as shown by the burning sensation which will be felt if irritation is being produced. It is not wise to allow these solutions to be retained after they become distinctly uncomfortable. The solution is readily kept in the urethra by closing the meatus with the thumb and forefinger.

As a corollary to what has already been said, it is clearly necessary to apply this solution to the urethra at least twice in the twenty-four hours, and the best result will probably be obtained in severe cases by administering an injection four times a day, or every six hours. This involves entrusting the treatment, in part, to the patient himself, and increases the danger of retrojection. It is probably best for the surgeon to give the first few treatments himself, so that the patient may thoroughly familiarize himself with the method. The practice formerly always advised, of making the patient protect the posterior urethra by sitting upon the edge of a hard chair, with a folded towel in the perineum, is losing favor. It is likely to bruise the bulbous urethra and to prevent the fluid from reaching the bulb, where it is needed, and it by no means always accomplishes the desired object. While the patient is obliged to use argyrol injections he should be provided with a solution of corrosive sublimate (1 : 500), which will remove like magic the spots caused by the argyrol. The strength of the solution and the number of the injections must vary with the stage and severity of the disease. The strength should be such as to produce but very slight burning, and the number of injections per day may be diminished as the discharge declines. Under this method it should be possible to control the discharge largely in from three to five days, after which time two injections a day will generally be sufficient. If protargol is to be used it may be given in the same way, but the strength of the solution must be very much diminished, generally a one- to two-per-cent solution being as much as the patient can stand.

Treatment of Acute Urethritis During the Stage of Decline.—As the inflammation begins to subside, the discharge will become muco-purulent and finally mucoid in character. During this time the indications for treatment change, the value of antiseptics diminishing, and the importance of astringents increasing. The action of astringents is to diminish congestion and therefore to combat the mucoid elements of the discharge, but the use of antiseptics is required as long as gonococci are to be found. With the beginning of the muco-purulent stage,—which, in favorable cases, may occur under this method of treatment during the second week,—astringents should be combined with antiseptics, and, although it is possible to obtain this effect to some extent by the use of a mixture, it seems wiser to employ the astringent and antiseptic injections in alternation rather than to depend upon "shot-gun" prescriptions. The most generally useful of the astringents are the combinations of zinc sulphate and lead acetate, or mild solutions of potassium. permanganate. The following prescriptions are examples of useful injections:—

℞ Zinc. sulph...... gr. ij.–vi.
Bismuth. subnitrat .... ʒ i.
Aquæ............fl ℥ iij.
Shake.

℞ Zinc. sulphocarbolat... gr. ss.–gr. i.
Aquæ........ fl ℥ i.

℞ Zinc. sulph..... gr. ij.–vi.
Liq. plumbi subacetat. dil..ad fl ℥ iij.

At the beginning of the muco-purulent stage the two kinds of injections may be used in the proportion of one astringent to two antiseptics, the patient thus employing an antiseptic injection in the morning, an astringent injection at noon, and an antiseptic one at night. If all goes well, the injections may be reduced to two—an antiseptic in the morning and an astringent at night. When the purulent discharge has largely disappeared and has given place to one of a mucoid character, the antiseptic injections may be diminished and the astringent continued. It is often wise to combine this method with the irrigation method later to be described, particularly in the later stages. The indications for stopping the treatment will be discussed farther on. (See page 771.)

Treatment of Acute Urethritis by Irrigation (Janet's Method).—This method was introduced by Janet and has since been modified by many different surgeons both in this country and abroad, so that, as regards the technique which is now generally employed, it is impossible to give credit where it belongs. The treatment is based upon the use of large quantities of dilute antiseptic solutions, and its value consists largely in the mechanical removal of secretion from the surface of the urethral mucous membrane. It is doubtful whether, in the strengths in which the solutions are used, they are of any real antiseptic value, but they are undoubtedly astringent, produce some congestion, massage the urethra by the constant distention and contraction, and in this way not only remove the surface secretion, but aid in the elimination of bacteria from the ducts and glands.

Solutions to be Used for Purposes of Irrigation.—The most commonly used solution is one of potassium permanganate, the strength of which at first should not exceed 1 in 5,000 or 6,000, while afterward, as the inflammation subsides, it may be increased up to 1 in 2,500 or 1 in 2,000. Perhaps the next most commonly used solution is one of silver nitrate, of a strength varying from 1 in 50,000 to 1 in 5,000. The latter is a distinctly irritating solution, and it is better to reserve its use for the stage of decline, or at least until the very acute conditions have subsided. The newer silver preparations have enjoyed some popularity. Bierhoff reports excellent results from irrigations made with a solution of protargol of 1 in 600 and 1 in 200. Argyrol, albargin, and many of the other newer products have been used, but it may be doubted whether, when diluted to this extent, they possess any value not possessed by salt solution. They are more valuable when employed by the method of injection. When the latter method is combined with that of irrigation, the urethra may first be cleansed with an irrigation of salt solution, boiled water, or a two-per-cent solution of boric acid, the object being simply to remove secretion and thus to allow the antiseptic to gain better access to the affected mucous membrane.

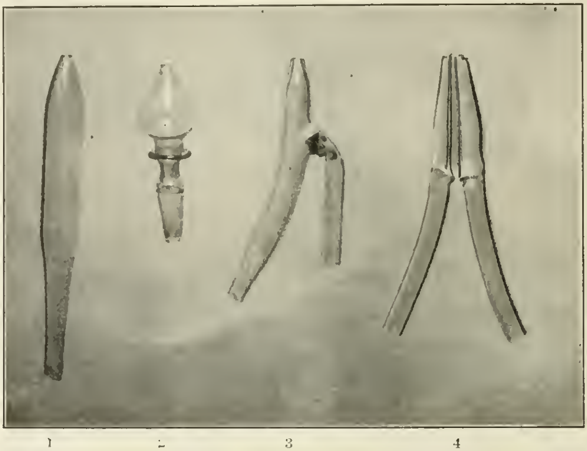


FIG. 518. Types of Nozzles used for Irrigation of the Urethra. 1. The straight blunt nozzle; 2. The bulb-pointed nozzle; 3. A type of "two-way" nozzle by which the fluid escapes from the urethra without removing the nozzle from the meatus; 4. The Kiefer "two-way" nozzle made of glass.

Method of Administering Irrigation.—The essentials of the apparatus are as follows:—a glass receptacle holding at least two quarts, with a rubber tube attached at its lowest point, through which the solution may run; an arrangement by which this irrigator can be adjusted at different heights; and a nozzle to fit the meatus. A great variety of nozzles have been provided, each of which has some advantages. It is essential to select one which will fill the meatus, which will not extend into the urethra, thereby causing irritation in the fossa, and which can be readily cleaned and sterilized. The accompanying illustrations show better than any description would, the various types in use. (Fig. 518.)

Irrigations may be given in the erect, the sitting, the semi-recumbent, or the recumbent position. Except for the saving of time and trouble, particularly in the management of a large clinic, I can see no advantage in the erect and the semi-recumbent positions. They are less comfortable to the patient, and, as the procedure not infrequently causes some distress, they unnecessarily increase the discomfort. Where possible, I have always employed the recumbent position, using either some form of self-draining table, or placing the patient's buttocks upon some form of douche pan.

The technique is a matter of some importance, and, if neglected, it is easily possible to carry infection into previously healthy portions of the urethra, even to the extent of infecting the prostate and bladder. The glans and region of the meatus should be carefully cleansed with the stream flowing from an irrigator placed at a level of three or four feet above the patient. Then, with the nozzle held close to the meatus, but not in contact with it, the surgeon should proceed to wash out the region of the fossa navicularis and the first inch or two of the pendulous portion. The nozzle is gradually approached to the meatus and the urethra is irrigated to a greater extent until the whole urethra in front of the cut-off has been thoroughly cleansed. (Figs. 519 and 520.) If the irrigation is done in this way the cut-off muscle will contract, and there will be no danger of retrojection. The great importance of this precaution will be appreciated when it is remembered that, in a certain number of cases, a very lax condition exists, and that, consequently, if the nozzle is applied snugly to the meatus, in a case of this kind, at once the flow will go directly back into the bladder without any opposition, and a quantity of infectious material will be carried over a previously healthy surface. If, after the anterior urethra has been efficiently irrigated, it is desired to force the cut-off and irrigate the deep urethra, at the same time distending the bladder, this can be done by raising the irrigator another foot or two, and applying the nozzle snugly to the meatus. If the patient will then relax the cut-off by attempting to empty the bladder and will breathe with his mouth open, the obstruction will give way. This can be felt by a series of little jerks, and the reluctance with which it yields can readily be measured. This

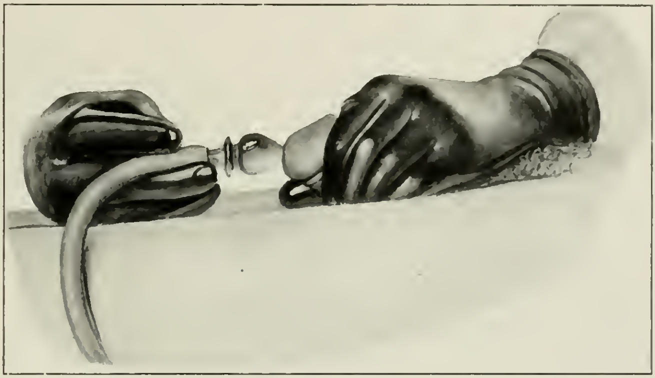


FIG. 519.—Method of Irrigating the Anterior Urethra with a Nozzle. Note the grasp of the penis with the whole hand, the fingers coming on the urethral side. The hold on the nozzle is very light.

having been accomplished, the injection is continued until the bladder is distended to the desired extent, and the patient then empties the bladder, washing the whole urethra again.

Irrigation of the Urethra with the Catheter.—The urethra and bladder may also be irrigated by the use of the catheter. Either this instrument may be introduced after the anterior portion has been irrigated, or the anterior urethra may be cleaned by slowly introducing the catheter, inch by inch, until the triangular ligament is reached. (Fig. 521.) The catheter is then pushed cautiously forward until the fluid ceases to return alongside it and can be felt to run forward into the bladder. This procedure is best carried out by using a large piston syringe in place of the irrigator, as the force used is thereby better regulated. With the catheter lying just within the prostatic urethra this portion may be efficiently washed and the bladder distended as with the irrigator.

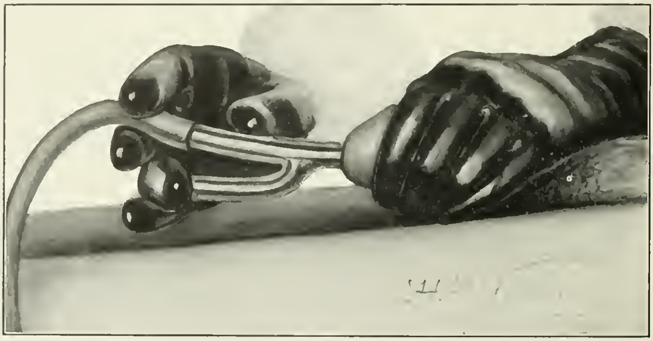


Fig. 520.—Method of Irrigating the Anterior Urethra with a Nozzle. The illustration shows the use of a "two-way" nozzle.

In cases in which the anterior urethra is in reasonably good condition and in which treatment is to be addressed chiefly to the posterior portion, the method by the use of the catheter has seemed to me preferable. If only small, soft catheters are used, extreme delicacy can be obtained, and there is perhaps less danger of using undue force than where the resistance is overcome by hydraulic pressure. On the other hand, the distending force of the irrigator is distinctly valuable in some cases, and in careful hands it is not objectionable. For the novice, or for one not in constant practice, the catheter seems to me a safer instrument. I scarcely need to add that all instruments are scrupulously to be sterilized. These methods are to be used only by the surgeon. I have occasionally known patients to employ them, but the results were not satisfactory.

During the acute stages the irrigation must be employed at least once in twenty-four hours, and better results will be obtained if it is done twice a day (night and morning) until the acute inflammation shall have subsided. If the irrigation is done twice daily, very dilute solutions must be employed, as it is quite possible to irritate the mucous membrane, and, while it is true that the acute phases are rapidly checked, there is some possibility of producing a chronic catarrhal condition which may prove quite intractable.

Though the method has been severely criticised in the past as likely to increase complications, notably posterior urethritis, prostatitis, seminal vesiculitis, and epididymitis, experience does not confirm the justice of such criticism. I am strongly of the opinion that, in competent hands, early local treatment is the surest safeguard against the very complications which it has been supposed to cause.

Treatment of Acute Posterior Urethritis.—As this complication may appear at almost any time during the progress of an anterior urethritis, a constant watch should be kept for signs of its occurrence. As already noted, these are chiefly to be found in turbidity of the second urine. This at first may not be very pronounced, and if doubt exists the irrigation test should be applied. In many cases the turbidity exists almost from the start and may be present when the patient is first seen.

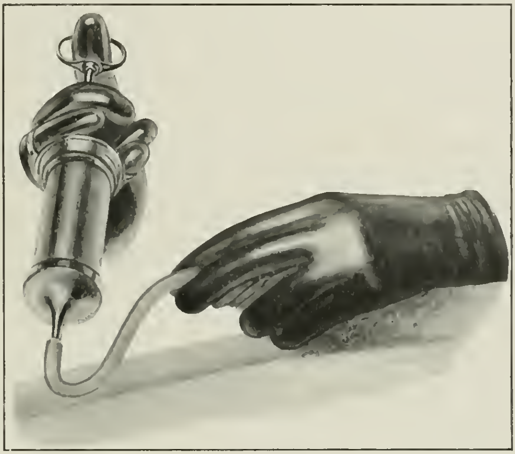


FIG. 521.—Method of Irrigating the Urethra with a Catheter. The illustration shows particularly the method of holding the penis with three fingers and controlling the position of the catheter with the second and third fingers. (N.B. The catheter and syringe are out of drawing, the catheter being too large and the syringe too small.)

Much difference of opinion has existed in regard to the indications for treatment. Many European authorities, particularly of the German school, have held that local treatment of a posterior urethritis was contra-indicated during the acute stage as more likely to aggravate than to improve the condition. On the other hand, many authorities in this country and many of the French school have advocated local treatment except during the most acute phases. It is clearly a sound procedure in the cases which show no symptoms and in which the presence of the disease is discoverable only by the condition of the urine. If the inflammation is allowed to go on without treatment an increase of the difficulty is to be expected, or at least the disease will show a marked tendency to become chronic, with involvement of the prostate. I believe that evidence does not support the contention that treatment properly carried out increases the probability of complications, and the same remark holds essentially true of the milder cases in which there are only slight frequency of micturition, slight urgency, and marked cloudiness of the second urine. I would even go further and advocate local treatment in cases in which the symptoms are not of the most severe type. It has yielded good results in my hands in cases where the frequency was well marked and the urine cloudy throughout, and where a distinct sense of weight and uneasiness in the perineum, together with moderate enlargement of the prostate, showed definite parenchymatous involvement of the organ. In the very acute cases accompanied by great frequency of micturition, tenesmus, a more or less constant desire to urinate, and evidence of serious involvement of the prostate, the wisdom of using local treatment is at least debatable. Many of these cases are really cases of prostatitis or urethrocystitis, and in fact no sharp line can be clinically drawn between these three affections. Where they exist it is probably safer to abandon local treatment and to adopt the line suggested under the Treatment of Prostatitis and Urethrocystitis. It should, however, be said that in some of these cases local treatment skilfully carried out has given good results, and it is by no means clear to my mind that it is always contra-indicated.

The method best suited to posterior involvement is that of irrigation, either with or without the catheter. Mild solutions are always to be preferred, and delicacy of handling is at a premium. Weak solutions of silver nitrate (from 1 in 50,000 to 1 in 10,000) have seemed most efficient. Weak permanganate or protargol solutions have also done well. The superiority of the catheter over the nozzle and hydraulic pressure is here most evident. If, after the anterior urethra has been efficiently flushed, a small, soft-rubber catheter is inserted into the membranous portion and the solution is injected slowly with a large syringe, the amount of force can be accurately estimated, and the amount of trauma reduced to a minimum. I do not think that in skilful hands the catheter used in this way does damage. In the more acute cases this treatment should be supplemented by rest in bed, if possible, and by hot rectal irrigations to be described under the heading of Treatment of Prostatitis.

In the cases bordering on urethrocystitis instillations of a rather strong solution of silver nitrate will sometimes act most beneficially. They are to be given with an Ultzmann syringe, and from fifteen to twenty drops of a 1 in 500 solution of silver nitrate are thrown into the deep urethra and on into the vesical neck when the bladder is empty. In the still more acute cases as eminent an authority as Keyes advises the instillation of a silver-nitrate solution (1 in 50), coupled with a hypodermic injection of morphia to control the pain and tenesmus. The effect of this method is sometimes almost magical in properly selected cases.

It should, however, be employed only by surgeons of experience and skill, as it increases the immediate discomfort, and also because its use is inadvisable except in a rather small and carefully selected group of cases. In the hands of the general practitioner irrigations with dilute solutions will prove the better routine method.

II. COMPLICATIONS OF ACUTE GONORRHŒAL URETHRITIS.

Acute Prostatitis.—Closely bound up with posterior urethritis is prostatitis. Clinically, no safe distinction can be drawn between the more severe types of posterior urethritis and the milder grades of acute prostatitis. It may, in fact, be doubted whether any sound pathological distinction exists. In practice, however, certain clinical differences may be noted. Three more or less distinct types are seen, though they grade insensibly into each other.

(1) *Acute Catarrhal Prostatitis.*

This is in reality nothing more than the extension of the inflammation into the glandular structures of the prostate, in precisely the same way as the glands and crypts of the anterior urethra are involved. No change is found in the shape, size, or consistency of the prostate as evidenced by rectal examination. The symptoms are of the mildest type and may be altogether lacking. The diagnosis depends upon the finding of pus and bacteria in the fluid massaged from the prostate after thorough irrigation of both portions of the urethra.

(2) *Acute Follicular Prostatitis.*

This is described by Finger as a distinct entity, but it corresponds quite closely to an advanced stage of the catarrhal type. The condition is similar, in all important respects, to the folliculitis of the anterior urethra, and results from the shutting off of the deeper portions of the glands from the surface by the inflammatory process, with the formation of distinct follicles and small follicular abscesses. The prostate is not enlarged, but little irregularities and thickenings are felt, particularly on either side of the median line. The amount of pus in the second urine is increased, frequency and urgency of micturition are marked though not severe, and intelligent patients will be conscious, as the muscular structures about the neck of the bladder contract upon the inflamed points, of a distinct contraction taking place at the end of urination. After a longer or shorter time these follicles will drain themselves into the urethra with an increase in the pus in the last portion of the urine. In typical cases the first urine may be somewhat cloudy, the second nearly clear with a few threads, and the last two or three drachms thick with muco-purulent material. This process terminates in one of the two orthodox ways—by resolution through spontaneous drainage of the follicles, or, as is rather common, by going over by degrees into the chronic follicular prostatitis, which is a not uncommon precursor of the so-called chronic posterior urethritis, which, in turn, in many cases, is nothing more than a chronic prostatitis.

(3) *Acute Parenchymatous Prostatitis.*

This is the common form of acute prostatitis associated with infections of the deep urethra. Its frequency can be estimated only approximately, and different observers vary widely in their estimates. Jordan, in 482 cases of acute gonorrhœa, found it in 3.7 per cent. This perhaps is a fair average. Like all varieties of prostatitis it never occurs except in the presence of posterior urethritis, and most commonly during the height of the disease. The onset is sudden; it is sometimes accompanied by chills and always by increased frequency of urination and by a feeling of weight and uneasiness in the perineum; and there is frequently some obstruction to the urinary stream. Constitutional symptoms (fever, increased pulse rate, and so forth) are the rule. In more severe cases the urinary urgency is extreme, and the emptying of the bladder does not relieve the symptoms, which amount to strangury. Terminal hæmaturia is not uncommon. The symptoms tend to increase in severity for from three to six days, and the disease may terminate either by resolution or by abscess formation. The prostate is much enlarged, occasionally reaching the size of a tennis ball, and can be felt in the rectum as a hot, exquisitely tender, almost pulsating mass. If resolution takes place without abscess formation, the prostate shrinks rapidly in size, and there is general subsidence of the symptoms. With the formation of an abscess, on the other hand, the symptoms continue, the outline of the prostate may become more irregular as the abscess bulges to one side or the other, and the temperature is likely to assume the remitting type. Chills are not uncommon. If not treated by incision the abscess will in time rupture, generally in one of three directions. Most commonly it opens into the urethra,—a course taken in more than half of the cases, and this spontaneous evacuation is signalized by a sudden increase in the amount of pus in the urine and by a marked improvement in the symptoms. Rupture not infrequently occurs at the time of the passage of a catheter, which may be necessary to relieve retention of urine. The next most common point of spontaneous rupture is into the rectum,—an event which occurs in perhaps fifteen per cent of the cases. Sometimes the abscess drains into the bladder, occasionally into a coil of small intestine, and in rare cases into the peritoneal cavity. Spontaneous rupture into the urethra or rectum is generally followed by cure, though a serious condition of chronic prostatitis practically always remains. Abscess of the prostate is always a serious condition; spontaneous drainage, as above described, is not a trustworthy method of cure and is not to be waited for. After the diagnosis is made it is always the duty of the surgeon to drain such an abscess surgically. When the diagnosis is difficult, he should make every effort to arrive at an opinion at the earliest possible moment.

Diagnosis of Acute Prostatitis.—The diagnosis of acute catarrhal prostatitis from a posterior urethritis is always difficult, frequently impossible. There is no notable change in the contour of the prostate, and the condition can be discovered only as a result of careful washing of the posterior urethra, followed by massage. If this shows the presence of pus in the expressed contents, the diagnosis is clear. The same holds true of the diagnosis of acute follicular prostatitis, though occasionally slight irregularities of consistency may be made out in the organ by rectal examination. Except in the hands of an expert the methods necessary for arriving at an accurate diagnosis trespass on the ground of meddlesome surgery, and, as the treatment does not essentially differ from that of posterior urethritis, little is to be gained from pushing the inquiry. With acute parenchymatous prostatitis the case is far otherwise. The symptoms must be distinguished from those of acute urethro-cystitis and occasionally from acute cystitis and acute pyelitis. This can be done readily by a rectal examination, which will show marked changes in the size and consistency of the prostate. It is always enlarged, always tender, often so much so that examination is made with difficulty. Of course, the presence of acute prostatitis does not bar out urethro-cystitis, and the two affections frequently coexist.

Treatment of Acute Prostatitis.—The treatment of acute catarrhal prostatitis and acute follicular prostatitis is essentially that of posterior urethritis as above described. Acute parenchymatous prostatitis calls, above all other things, for rest, both general and local. The patient should at once be put to bed and quiet must be insisted upon. The great frequency of urination must be controlled, since it is not only a cause of decided discomfort to the patient, but the constant violent contractions of the neck of the bladder tend to aggravate the condition in the prostate. For this purpose opium is the only valuable drug, and should be pushed until reasonable comfort is obtained. Although it is customary to give it by the rectum, in the form of a suppository, I have never seen reason to suppose there was any special virtue in this method; and, besides, the drug acts much more promptly if given by mouth or subcutaneously. Morphia is the best preparation and should be given in doses of from $\frac{1}{6}$ grain to $\frac{1}{4}$ grain. Next in importance comes the local application of heat. This may be used in two ways: either in the form of a poultice or a hot-water bottle applied to the perineum, or in that of hot rectal irrigations; or, better still, both methods may be used. The heat may be applied to the perineum continuously. Hot rectal irrigations should be given by means of a special tube (such as Kemp's or Chetwood's) which is provided with an inflow and an outflow, through which a constant stream of hot water is kept flowing gently through the rectum. It is not necessary that the flow should be rapid, and the bag or reservoir need not be more than a foot or two above the level of the bed. The temperature of the water should be between 110° and 120° F. and should be as constant as possible. There is some danger that these irrigations may unduly irritate the mucous membrane of the rectum, and they should therefore not be given for more than an hour at a time and should be separated by an interval of two or three hours. As the symptoms subside they may gradually be omitted. The use of cold water in a similar way has been advised, but has not seemed to me to give as much relief; and, except in the early stages, this is not to be expected. The general treatment should consist in light diet, liquid or semi-solid, with careful attention to the condition of the bowels. The administration of balsams by mouth, if the stomach will tolerate them, has undoubtedly some favorable influence on the condition of the urethra.

Abscess Formation.—A careful watch should at all times be kept for evidence of abscess formation. Persistent inflammation with continued fever generally means a deep-seated abscess. If the abscess approaches the rectum its presence can be felt as a softening at some point on one side of the middle line. The decision when to operate is a much-mooted one, but there is an increasing tendency, as in other branches of surgery, to operate early, with a view to avoiding great destruction of tissue. Most excellent work on this subject has been done by Alexander, of New York, who inclines to operate early when acute inflammation develops in the course of an acute urethritis, even should there be no fever. The more conservative opinion will probably hold that, as certain of these cases go on to resolution, it is wiser to reserve operation for those in which considerable tissue destruction seems inevitable. If, after several days, the fever and inflammation persist, it is probably wise to resort to free drainage.

Operative Treatment.—The two routes by which the prostate gland may be approached are through the perineum and through the rectum. The old teaching was that all abscesses pointing toward the rectum should be opened by that route, and, although it has been held that the danger of mixed infection from the bowel by this method is great, the fact remains that the vast majority of properly selected cases thus treated go on to complete recovery. In spite of weighty opinion to the contrary I still believe that, when a well-defined crater can be felt on the rectal aspect of the prostate, a free incision by this route is as likely to result in cure without complications as by any other method. In all cases in which the presence of pus is doubtful, or in which there is no certainty of pointing toward the rectum, the perineal route is to be preferred.

These operations are best done under a general anaesthetic. The patient should be placed in an exaggerated lithotomy position, and the perineum should be opened either by a vertical or by a curved incision in front of the anus. By those who are thoroughly familiar with perineal surgery the vertical incision will probably be preferred, but, in the case of a beginner or of one little versed in this branch of work, the curved incision is probably preferable, as it will give a better view of the field and is less likely to damage the rectum. In any case the prostate should be freely exposed and the urethra opened at its apex. The finger is then introduced and pushed forward, dilating the prostatic urethra and splitting the prostate upon either side. If an abscess is present it will readily be felt, especially if counter-pressure is made with the finger in the rectum. Once the abscess is opened, all partitions and cavities should be freely broken into, and every effort made not to leave any partially drained cavity. A large drainage tube is then inserted through the perineum into the bladder and secured in place. A light gauze packing in the wound is generally useful. In some cases —and these will be more commonly encountered by those who incline to operate early—no distinct or massive abscess will be found, but one or both lobes will be studded with small abscesses and more or less honeycombed. For these cases prostatectomy as advised by Alexander seems particularly applicable, and, although it is a radical operation and one which results in sterility, nothing less radical will afford a permanent cure. In some of these cases the decision is a very difficult one, and, if possible, should be left to one familiar with this branch of surgery.

Gonorrhœal Cystitis.—True gonorrhœal cystitis—that is to say, a general infection of the bladder due to the gonococcus—is a rare disease. The term is, however, used to cover a variety of inflammatory processes which originate in the deep urethra and which may involve the adjacent part of the bladder wall. Three processes are commonly confused:—(1) Acute posterior urethritis; (2) acute posterior urethritis, with involvement of the trigonal portion of the bladder (the urethro-cystitis of Finger); and (3) true acute cystitis. Processes (1) and (2) run insensibly into each other, and in many cases of posterior urethritis there is some infection of the bladder wall. The third is practically always an extension from the previous ones, and in this way all three may be considered together. They all arise from, or in connection with, an acute urethritis which has extended backward, first involving the deep urethra and then spreading to other structures. It has been held that the more general inflammation of the bladder is always due to a mixed infection, but this is clearly not the case, as the gonococcus has been isolated in pure culture from some of these cases and is undoubtedly capable of causing this process. That in some cases there is a mixed infection, one in which the colon bacillus generally takes part, is not to be denied.

SYMPTOMS.—The symptoms are generally those of posterior urethritis with some superadded symptoms of cystitis. Subjectively, the symptoms are those of posterior urethritis. The condition of the urine is such as to suggest a cystitis. Pain is always present, with frequency of urination, which is generally not relieved by emptying the bladder, except in the subacute cases with moderate inflammation of the trigone, when symptoms are marked only in the erect position and are relieved by lying down. This relief is due to the fact that pressure is relieved about the internal urethral orifice as the urine flows back into the fundus of the bladder.

The urine is cloudy in both portions, the second portion frequently more so than the first. It not infrequently happens that the first urine is very cloudy and the second urine distinctly clearer, while the third urine is thick with pus. This is due to the tendency of pus to collect in the bladder and to settle to the bottom, leaving a clear portion of urine above. In well-marked cases there may be a little blood at the end of micturition, as the bladder contracts. Examination of the sediment will show a disproportionate amount of bladder epithelium, thus distinguishing it from the very purulent urine which is associated with inflammation of the prostate. The amount of systemic disturbance will of course vary with the severity of the process, but is generally moderate. True acute gonorrhœal cystitis differs from the above only in a greater systemic disturbance and in being characterized by moderate tenderness over the fundus of the bladder. The urine in these conditions is, as a rule, acid.

Treatment.—The treatment is essentially that of posterior urethritis, combined with such measures as are commonly employed in cystitis due to other causes. Rest in bed, opium, local applications of heat, the administration of balsams by the mouth, and diuretics in moderation are indicated. The skilful use of irrigations and instillations, as described in the section on Treatment of Posterior Urethritis, is of great benefit. Conversely, rough or unskilful instrumentation is worse than no treatment.

Acute Epididymitis.—As we are here considering epididymitis only as a complication of gonorrhœal urethritis, it is unnecessary to discuss any of its other varieties.

Etiology.—Acute epididymitis, like many of the other complications just considered, never occurs except in the presence of posterior urethritis. It is due to direct extension of the inflammation along the vas and is caused by the gonococcus. It has frequently been said that this complication is due to a mixed infection and not to the gonococcus, but recent work makes it clear that the gonococcus is the prime offender, though the infection may be and doubtless sometimes is a mixed one. Its sudden occurrence almost without warning, in the absence of symptoms suggesting inflammation of the vas, has led to the belief that it is metastatic in origin, but this is not the case; the explanation lies in the fact that the vas presents much less favorable ground for the growth of the infective organisms, and may be touched very lightly by the descending infection, or may harbor the infection for only a very short time. The symptoms of vas inflammation are very trivial, though in the vast majority of cases some thickening of the scrotal portion of the vas can be made out.

The frequency of this complication is not easy to estimate. Jordan found that it occurred in only 95 out of 812 cases—11.7 per cent. Pezzoli-Porges found that it occurred in 559 out of 3,934 cases—14.2 per cent. Finger states that it occurs in fully 28 per cent of hospital cases. It comes on commonly during the second, third, fourth, or fifth week of the disease, but its occurrence may be delayed for two or three months, or even for several years; and then, on the other hand, it is occasionally seen in the first week of the disease. It is generally unilateral, and one side is involved about as often as the other. Thus, in 3,136 cases, Finger found it in the right side 1,500 times, on the left side 1,425 times, and on both sides 211 times.

In many cases there is no predisposing cause. Some of the most skilfully and carefully handled cases will acquire the disease, while other patients who grossly neglect treatment escape altogether. Undoubtedly lack of attention to personal hygiene, failure to observe ordinary precautions in regard to diet, alcohol, etc., and other forms of gross carelessness, predispose to this complication. A severe urethritis is probably more liable to cause trouble than a mild attack. Careless use of injections or indeed carelessness in any form of local treatment is of course likely to lead to trouble, but only in so far as it predisposes to posterior urethritis. On the other hand, I am fully convinced that the modern local treatment of the urethra is the best insurance against this or indeed any other complication. Finger studied 576 cases with this particular complication in view, and found that it occurred 264 times in patients who had no treatment, 73 times in patients treated by medicine alone, 82 times in patients treated by injection, and 60 times in patients treated by medicine and injections, while in 97 cases the treatment was unknown. These figures require no further comment. Lastly, there is the factor which is spoken of as an idiosyncrasy—which is, of course, another way of saying that there exists, in the patient himself, some predisposing cause of which we are ignorant.

Pathology.—Though our knowledge of the disease dates back to ancient times, very little is known about the pathology of acute epididymitis. This is due to the fact that the material has been largely lacking. As the practice of operating for the relief of this process becomes more general our knowledge will doubtless be rapidly extended. The lower portion of the vas is usually thickened and may be expected to show the infiltration in the upper layers. The process is generally most active in either the upper or the lower portion of the epididymis, the lower portion or the globus minor being more commonly involved. It is generally stated that abscess of the epididymis is rare, but recent contributions made by Hagner and others render this doubtful, and the formation of small abscesses is probably the rule in severe cases. Frequently an excess of fluid is poured out into the cavity of the tunica vaginalis, and there is then formed an acute hydrocele. In some severe cases this accumulation is purulent, and obliteration of the cavity of the tunica vaginalis is frequently found at operations for obstruction of the epididymis. Involvement of the testicle itself, or orchitis, is always secondary and rarely serious. With the active process in the epididymis there is usually more or less œdema of the overlying loose connective tissue and also of the skin of the scrotum.

Resolution takes place by absorption of the exudate, a variable amount of scar tissue being left in and about the epididymis. These nodules persist for months, years, or even permanently. In what proportion of cases complete destruction or obstruction of the tube of the epididymis occurs, cannot be stated. I am inclined to think that the permanent damage is greater than has been generally suspected.

Symptoms.—The onset may be extremely sudden or rather slow, and is commonly preceded by a sense of weight and uneasiness in the scrotum for many hours or even for several days. In the most acute cases there is practically no warning, and I have known a sudden muscular exertion to be instantly followed by pain in the scrotum so severe as to be almost disabling. This was promptly followed by swelling and other classical symptoms. In the average case there can be felt, within a few hours after the onset, a distinct swelling of the epididymis, and this increases rapidly until the line between the epididymis and the testicle is obliterated. The whole side of the scrotum is swollen and the overlying skin is red. The pain in the region of the testicle is usually severe: it is of a dragging, sickening character, and, in the worst cases, renders locomotion difficult or impossible. Dragging pain in the back is common, but is generally a minor consideration. If left to itself the swelling increases for two or three days, remains stationary for several days, and then gradually subsides. The affection has many of the characteristics of a self-limited disease. In bilateral cases it is common to find the second epididymis involved at about the time when the one first attacked is quieting down. In moderate cases the process will be quiescent in ten days, while, in the more severe, three weeks or more may be required. Some cases show a marked tendency to relapse as soon as the patient is allowed to be up and to move about, and one relapse may then follow another with trying persistency. In most of the cases there is some constitutional disturbance, the temperature occasionally rising to 104° or 105° F., with corresponding increase in the pulse-rate. This disturbance, however, rapidly subsides, and after a few days the temperature will be found to have returned substantially to normal.

Diagnosis.—Epididymitis presents no difficulty in diagnosis. Even in the mildest cases some thickening of the epididymis is to be felt and some tenderness, while in the vast majority of cases the patient will himself make the diagnosis within a few hours. The only possible source of confusion lies in the exacerbations of a smouldering tuberculous epididymitis, the presence of which has been overlooked. Cases are occasionally seen in which a smouldering posterior urethritis coexists with a tuberculous epididymitis, and in these cases it may be impossible to decide whether the acute process is due to the gonococcus or is a lighting up of the tuberculous process. The course of the disease will, as a rule, lead to a correct diagnosis.

Prognosis.—The prognosis as to life is practically always good, the rare cases of septicæmia, pyæmia, or peritonitis being surgical curiosities. The outlook for the testicle is likewise always good. For the epididymis, however, it is far otherwise. As already stated, we are in no position to estimate the frequency with which permanent occlusion occurs, but I believe it to be common. The figures in regard to sterility are very unsatisfactory. Benzler, as the result of examinations of soldiers in the German army, found 23 per cent of sterility in unilateral epididymitis, 41 per cent in bilateral. These figures are, I believe, somewhat below the mark, but a more searching examination is necessary before a sound judgment can be reached. The subject is distinctly a neglected one.

Treatment.—In all but the mildest cases rest in bed is imperative. At the outset all local treatment of the deep urethra should certainly be suspended; and probably the same advice holds good with reference to local treatment of the anterior urethra. To the local palliative treatment of epididymitis little has been added in recent years, though it is by no means brilliantly satisfactory. The scrotum should be supported efficiently so as to discourage the occurrence of œdema and to favor free circulation. (Fig. 522.) The most comforting application is heat, preferably in the form of flaxseed poultices, which are far superior to any form of heater or hot-water bottle. The application of cold has many advocates, but, except, in the early stages, cold is not as grateful as heat, and under its influence the process does not subside with the same rapidity. Heat, as far as I am aware, never does harm, while I have twice seen sloughs of some size and great persistency result from the enthusiastic use of the ice-bag.

A great variety of local applications have been tried, but only two have stood the test in my hands. Of these, guaiacol, in fifty-per-cent solution, is the most satisfactory. If applied at the outset, it will occasionally jugulate the disease; it nearly always affords marked relief from pain and, beyond superficially reddening the skin of the scrotum, never does harm. The application of pure guaiacol may produce more brilliant results, but it is also more uncomfortable. Solutions of less than fifty-per-cent strength may be used in mild cases. Applications should be made once or twice a day according to indications. Silver-nitrate solutions, of a strength of ten per cent, exert a somewhat similar effect. Their action is less certain; they also produce more irritation of the skin and they possess no notable advantage over guaiacol. These local applications are in no sense a substitute for poultices; and the two may be used together with the best results.

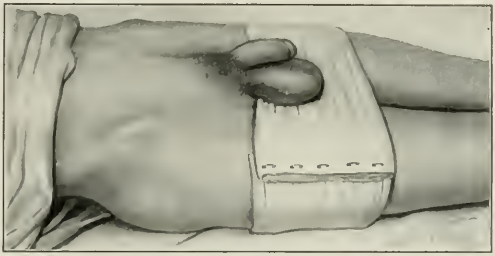


FIG. 522.—A Method of Supporting the Scrotum During the Acute Stage of an Epididymitis

General Measures.—The balsams may be administered for their beneficial effect upon the urethral mucous membrane; but, aside from these, no medicinal treatment has any effect upon the course of the disease. The diet, the care of the bowels, etc., are such as are ordinarily indicated in inflammatory conditions.

In from three or four days to a week the swelling begins to subside, and this is an indication for a change from local applications and poultices to strapping. The end to be gained by strapping is more or less uniform compression, with a view to hastening absorption of the exudate. A great variety of methods have been used, none of them very satisfactory on account of the anatomical arrangement of the parts. They all seek to produce uniform pressure without persistent or lasting discomfort. The common method—that by the use of adhesive plaster—is difficult, uncomfortable, and inefficient. Keyes' method of using a rubber bandage, fastened with adhesive plaster, is better in all respects; but it is not entirely satisfactory. This method is as follows:—A piece of light rubber, such as is used by dentists for making dams, is cut 15 or 20 cm. long and 10 cm. wide; to the end of this a piece of adhesive plaster 1 cm. wide and about 10 cm. long is attached. The affected side of the scrotum is then taken firmly in the hand, the unaffected side being pushed up out of the way. The rubber bandage is wound snugly about the scrotum in such a way that the line of greatest pressure comes above the line of greatest swelling. It is then fastened by means of the adhesive plaster. This apparatus can easily be removed and readjusted, —an advantage which is shared by no other method.

Strapping should be continued until practically all the swelling has gone down and only thickening of the epididymis remains. I have been unable to see that any treatment had marked effect upon the absorption of the residual hardening; time alone will effect its removal. It not infrequently happens that all goes well until the patient is allowed to be out of bed. Then the pain and the swelling return, and no other course is open to the patient but to resume a recumbent posture. In some of the stubborn cases this may occur again and again, and I vividly remember one patient who spent a whole summer vibrating between his bed and his office, in the proportion of about 6 to 1. For cases of this type, operation as about to be described, is clearly indicated.

Operative Treatment.—During the last few years attention has been attracted to the operative treatment of acute epididymitis, particularly by the contributions of Bazy, Belfield, and Hagner. These gentlemen have clearly shown that early incision and drainage of the inflamed epididymis and tunica vaginalis promptly relieve pain, prevent the tendency to relapses, and apparently leave the epididymis no more damaged than it is when subjected to the orthodox methods. Until our experience shall have extended over a larger number of cases, it is advisable that the operative treatment should be reserved for the more acute cases, in which the pain is severe and the swelling great, or for those cases which, having begun to quiet down, continue to flare up whenever the patient attempts to go about his business.

Technique of the Operation.—The operation itself is quite simple and is best done with the aid of a general anæsthetic. The scrotum is prepared as for any surgical operation and an incision two or three inches long is made upon the outer side at about the junction of the epididymis with the testicle. The tunica vaginalis is freely opened and the contained fluid, either serous or purulent, is evacuated. The red swollen epididymis will then be seen projecting into the cavity of the tunica vaginalis. Hagner advises that it be punctured in many places with the point of a narrow-bladed knife, until pus is found or its absence demonstrated. The wound is then freely washed out with salt solution and lightly packed with gauze. Prompt relief of pain seems to be the rule. The wound heals rapidly, and confinement to bed should not exceed a few days or a week. The promise from this operation is such that it should be widely tried, and it will, I believe, prove of permanent value. The operative treatment of the occlusion of the epididymis, which condition results from acute inflammation, belongs rather to treatises upon diseases of the testicle and need not be considered here.

Folliculitis; Periurethral Abscess; Cavernitis; and Cowperitis.—*Folliculitis.*—The term folliculitis is used to cover inflammatory processes of the many follicles which are situated along the course of the urethra. Some degree of follicular inflammation is an essential part of every urethritis, but it is only when these follicles assume such size as to be demonstrable that the affection can be dignified by being termed a complication. In their mildest form these inflamed follicles are to be felt as little shot-like bodies along the palpable part of the urethra. They occur more commonly upon the roof, where follicles are more numerous, but are most readily felt upon the floor. There are certain regions which are particularly liable to be affected: for example, the glands at the anterior extremity of the fossa navicularis, those in the region of the peno-scrotal angle, and those in the bulb. Two follicles situated within half an inch of the meatus are commonly involved. They appear as little swellings in the pockets on both sides of the frenum and generally go on to suppuration. (Fig. 523.) They usually drain externally and not into the urethra. The ducts of these glands are generally to be seen through a wire speculum, and are always readily distinguished in cases of slight balanitic hypospadias.

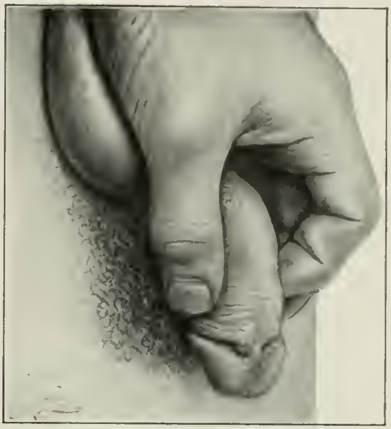


FIG. 523.—Suppurative Folliculitis Complicating Gonorrhœal Urethritis. A typical suppurating follicle beside the frenum.

Most of the follicles when inflamed show a commendable tendency to drain into the urethra. Not very infrequently, however, the ducts become obstructed, the products of inflammation break through the capsule of the gland, and periurethral abscess results. This appears at first in the form of a fairly large swelling, generally at the side of the urethra. This swelling increases rapidly in size, with reddening and œdema of the overlying skin, and in due time the abscess ruptures—externally in the majority of cases, less frequently into the urethra, and only rarely in both directions. When it ruptures into the urethra there is considerable danger that urine will leak into the cavity and that urinary infiltration will result; but when it ruptures externally, healing generally takes place rapidly. When rupture takes place in both directions there is left a urinary fistula, which, although it wards off the danger of urinary infiltration, is apt to result in a fistula, the closure of which is often difficult to obtain. When such an abscess occurs in the region of the bulb, the swelling may be diffuse; the whole perineum may be converted into a red, hot, and angry-looking tumor.

Treatment.—The small inflamed follicles along the urethra frequently take care of themselves, finally draining into the urethra, usually after the lapse of a few weeks. Where the inflammation persists it is possible to assist drainage by identifying the opening of the duct through a urethroscope and enlarging it by a short incision with a Kollmann knife. This operation is a delicate and difficult one and likely to fail except when executed by an expert. Where the duct is open, the follicle discharging into the urethra but not healing, the cavity may be injected with an antiseptic solution by means of a long filiform syringe. This also is a delicate procedure. In some of the more chronic cases I have thought that massage of the urethra upon a sound hastened the process by tending to empty the glands, but I am by no means sure that benefit resulted. The two glands above referred to, which appear upon both sides of the frenum, are rather likely to be involved simultaneously and generally rupture externally. They show a marked tendency to perforate beneath the frenum, leaving a troublesome bridge of tissue. Much trouble may be saved by promptly incising them transversely, so as to divide the frenum. The wound then heals promptly and practically without deformity.

Periurethral Abscess.—Periurethral abscess of any size is a serious complication. Not only are infiltration of urine and urinary fistula to be feared, but the excessive vascularity of the parts makes absorption rapid and pyæmia an occasional result. There has been a distinct tendency to temporize too much with these abscesses, and the fear of doing damage to structures with which the surgeon was unfamiliar has prevented their being handled in a vigorous and effective manner. If dealt with upon the principles governing the treatment of abscess elsewhere they will show good results. As soon as the presence of pus is probable, or even to be suspected, they should be freely incised, care being taken not to open the urethra if this can be avoided. It is particularly in the region of the perineum that prompt, free incision of such an abscess is likely to prevent serious destruction of tissue or even sloughing of large portions of the bulbous urethra. Where rupture into the urethra and infiltration of urine have occurred, prompt, free incision is demanded. Under these circumstances urethral fistula, of course, results, but tissue destruction is lessened and the fistula can be dealt with later when the acute process has subsided.

Cavernitis.—More rare than folliculitis is inflammation of the corpora cavernosa—cavernitis. This results from an extension of the inflammation in the urethra through the connective-tissue covering. In acute cases a rapidly extending diffuse inflammation, often apparently involving the whole pendulous portion, appears, and under these circumstances it is hard to localize the focus of the disease. The process is an active one, cellulitis is extremely common, and pyæmia is not rare. Here, as in periurethral abscess, there has been too much tendency to temporize, and there can be scarcely any doubt that a free early incision would materially diminish the danger to which the patient is exposed. With the patient under the influence of a general anæsthetic there should generally be no difficulty in making out the point where the process is most active, and it is at this point that the incision should be made. The resulting scar always hampers the cavernous tissue to some extent, makes its distention irregular, and causes, as a rule, some deformity.—There is also a rare variety of cavernitis which is, so to speak, chronic from the start. It is a slowly advancing fibrous infiltration of the cavernous tissue, and frequently results in much deformity.

Cowperitis.—Cowper's glands, two racemose glands situated between the layers of the triangular ligament and communicating with the bulbous portion of the urethra by long ducts, are probably more commonly involved in urethral inflammation than is generally appreciated. Acute Cowperitis is relatively easy to demonstrate. It comes on, as a rule, in the second to the fifth week of an acute urethritis, and the patient's attention is first attracted by soreness in the perineum. Examination at this time, with the patient in the lithotomy position, will show a point of tenderness about one inch in front of the anus and to one side of the middle line, and generally a small though distinct tumor can be felt. The process is ordinarily a mild one and quiets down without treatment beyond general care of the urethra. In some cases, however, it goes on to suppuration, with the formation of an abscess, which generally ruptures externally, discharges, and heals. More rarely, the abscess communicates also with the urethra and a urinary fistula results. The rôle of these glands in the production of chronic urinary fistulæ, often improperly supposed to be ruptures of the urethra behind a stricture, has frequently been overlooked. The work of Alexander and Motz shows clearly that these glands are often involved in the chronic urethritis which occurs with stricture and that the inflammation often leads to fistulæ. The frequency of chronic Cowperitis is very difficult to estimate. Unless the glands are considerably enlarged they cannot be felt, and I am inclined to think that they play a larger rôle in the persistent gleety discharge of chronic urethritis than they have been credited with.

Infection of Periurethral Ducts, and so-called Supernumerary Meatuses.—Among the anomalies of the urethra occasionally seen are ducts, of greater or less length, which start near the meatus and run backward more or less parallel with it. More common are the cases of false or blind meatus. This condition generally occurs in cases of moderate balanitic hypospadias in which, above the true opening of the urethra, is found a depression, sometimes an eighth of an inch in depth, which ends blindly. These anomalies are interesting in the present connection because these ducts or depressions are not infrequently infected with the gonococcus, and the infection may here persist long after the urethral lesion has healed and thus perpetuate the disease. If the possibility of their presence is borne in mind they cease in great measure to be a source of danger. Their treatment is often difficult because of their length and small calibre, and it is by no means easy to eradicate the infection. The injection of strong antiseptic solutions by means of a blunt hypodermic needle will generally effect a cure. Should this fail, free opening of the duct or even its excision may be required.

Balanitis or Balano-Posthitis.—Balanitis is an inflammation of the surface of the glans, while posthitis is an inflammation of the inner lamella of the prepuce, which lies directly in contact with the surface of the glans. It is evident that inflammation of one of these membranes cannot long exist without the involvement of the other, so that the term balano-posthitis is anatomically more accurate. The term balanitis is, however, used to cover both conditions.

The process is a complication of gonorrhœal urethritis only in a quite accidental way. It arises from irritation from any source, and in this way a gonorrhœal discharge may act as a source of irritation. Except in persons of uncleanly habits, or in the presence of phimosis, it is not a common complication.

Pathology.—In the milder degree there are redness, slight swelling, and loss of the surface epithelium in larger or smaller patches. In more severe cases there is œdema both of the glans and of the prepuce, and the loss of epithelium may go on to shallow ulceration. With the occurrence of œdema may come phimosis sufficient to prevent retraction of the prepuce. When this occurs a sort of vicious circle is set up, in which the retained secretion becomes an active irritant, the ulceration becomes more extensive, and the swelling increases; in fact, in the worst cases this state of affairs may go on to gangrene and sloughing. While sloughing is by no means uncommon in the balanitis which accompanies chancroidal ulceration, it is extremely rare in the form which accompanies gonorrhœa; the process, in this form, almost never going beyond the production of a marked œdema of the whole penis and some inflammation of the inguinal lymph nodes. The latter, however, almost never suppurate.

Symptoms.—In the milder forms there are slight itching and burning with some redness of the surface. When the inflammation becomes more severe there is distinct œdema of the dependent portion of the prepuce. Ordinarily, this produces partial phimosis, without seriously obstructing retraction of the prepuce. The œdema, however, may be sufficient to cause some retention of the secretion and thus aggravate the inflammation. Where balanitis occurs in the presence of a phimosis, or when the swelling is sufficient to cause a marked degree of the latter condition, the inflammation is at once aggravated, the secretion being much increased in amount and not infrequently changed in character through the admixture of a certain amount of pus. The parts are generally reddened, especially about the free border of the prepuce, and this reddening extends upward and toward the pubes. At times there are red streaks of lymphangitis, with redness and swelling of the inguinal lymph nodes. In extreme cases the swelling may be great, and, on account of the slowing of the circulation, the color may be bluish or cyanotic. In general, the amount of discharge is closely related to the severity of the inflammation.

Diagnosis.—The determination of the existence of a balanitis generally presents no difficulties, and the only questions which cause any trouble are those relating to its etiology. Thus, it is by no means always easy to distinguish the varieties due to uncleanliness or irritation of urethral discharge, from that which is due to chancroidal or specific ulceration. In the absence of phimosis the diagnosis should present no difficulties. Retraction of the prepuce will show characteristic reddening of the glans, with loss of surface epithelium, and these alterations will at once distinguish the affection from simple retention of urethral discharge, on the one hand, and from the deeper and more marked ulcerations of chancroid, on the other. The presence or absence of urethral discharge can also at once be ascertained.

Where marked phimosis exists and the prepuce cannot be retracted, the diagnosis is much more difficult. (Fig. 524.) Here the discharge from the opening may look precisely like that of an acute urethritis, and it is then impossible to say, from mere inspection, whether it comes from the preputial sac, or not. It is a common error to regard a swollen prepuce, with free purulent discharge, as significant of acute urethritis. Where such a condition exists, error can be avoided by carefully irrigating the cavity of the prepuce, for which purpose a blunt-nozzled syringe, or better still a catheter, should be used. If, after this has been done, it is found possible to retract the prepuce sufficiently to expose the meatus, the presence or absence of urethral discharge containing the gonococcus may readily be ascertained. If such retraction cannot be effected, the patient may be told to pass his urine into two glasses, when cloudiness of one or both portions, together with the demonstration of the gonococcus in the pus, will lead to a correct diagnosis. If, on the other hand, the urine is clear in both portions, the condition is evidently one of pure balanitis. In the presence of a tight phimosis it is a more difficult matter to make the distinction between simple balanitis and that due to chancroidal or specific infection. As a rule, it is possible to feel the ulceration due to chancroid even through the œdematous prepuce, and chancroidal ulceration about the edge of the prepuce is likely to occur, while, in specific lesions, the induration and thickening of the ulcer are likely to be quite appreciable. In both of these conditions the involvement of the inguinal lymph nodes takes place more promptly and is more pronounced; that of chancroid showing distinct inflammatory conditions, while that of syphilis shows the hard discrete adenopathy characteristic of the disease.

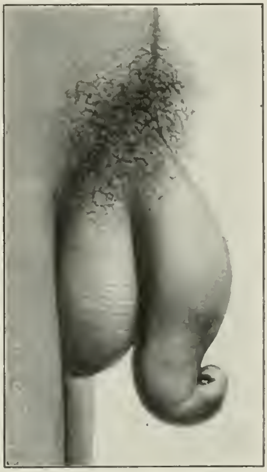


FIG. 524.—Balanitis Complicating Gonorrhœal Urethritis. In this case the prepuce was so swollen that it could not be retracted and the diagnosis was made only after thorough irrigation of the preputial sack.

TREATMENT.—The remarks which were made in reference to the differential diagnosis apply with equal force to the treatment. The cases without phimosis are easy to cure, while those with phimosis are more difficult to manage. In the mild cases the secretion should be washed off with some bland solution or with simple warm water. The surface should be carefully dried and then powdered with boric acid and talcum powder in equal parts, with finely powdered boric acid, or with calomel. These measures should be carried out by the patient two or three times a day, and a cure will generally result in a few days, provided that the urethral discharge is properly attended to. In the more severe cases, in which it is possible to expose the surface, it may be well to wash it with some antiseptic solution (*e.g.*, corrosive sublimate 1 : 5,000, carbolic acid 1 per cent, or silver nitrate 1 per cent) and then to apply powder as before.
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Where retraction of the prepuce is impossible, treatment is less effective. The cavity of the prepuce should be irrigated two or three times a day with a solution of boric acid (2 per cent) or of corrosive sublimate (1 : 5,000). If this is carefully done and if the urethral discharge is properly treated, the inflammation will as a rule quiet down in a few days, so that the prepuce can be retracted and the treatment carried on as above suggested. In the more severe grades, with great œdema, profuse discharge, etc., it may be wise to soak the whole organ in a hot solution of boric acid for half an hour or an hour twice a day, irrigations being employed at the same time in the manner described above. In the worst cases confinement to bed may be necessary. Where gangrene or sloughing threatens, a dorsal incision may be required, but this is practically never necessary in the form of balanitis which complicates gonorrhœa, though it is quite often needed in balanitis due to chancroid.

III. CHRONIC GONORRHŒAL URETHRITIS.

To describe chronic urethritis as a whole, as a process involving both the anterior and the posterior portions of the urethra, would be logical and proper, were it not for the fact that the human mind is incapable of grasping a mass of correlated conditions thus broadly grouped. That chronic anterior urethritis and chronic posterior urethritis frequently coexist should not, however, be forgotten, although, in the interest of clearness, it is better to consider them separately.

Chronic anterior urethritis is a direct sequel to acute urethritis, and it is not always easy to say at exactly what moment of time it should be termed chronic. In general, it is proper to regard as chronic those cases which, having passed through their acute symptoms, become more or less stationary. Some apparently acute infections become chronic within a week or two, and others, one might almost say, are chronic from the start. Then, again, there are cases which cannot be said to become chronic until after the lapse of two or three months.

The pathological changes of chronic anterior urethritis may be divided into superficial and deep—those involving the mucous membrane and the lining membrane of the glands, and those in which the process has extended into the periglandular connective tissue, and in which connective-tissue changes are primarily at fault. The superficial changes are relatively unimportant and consist in chronic infiltration of the surfaces with its accompanying chronic congestion and the catarrhal processes in the glands and ducts. From these superficial changes there occasionally results a peculiar alteration of the epithelium from the cylindrical to the flat type, in which it more nearly resembles the epithelium of the skin. It is doubtful, however, whether these changes of structure occur in purely superficial processes. They are associated unquestionably with the deeper connective-tissue changes. With this group may be described the so-called granular or granulating patches along the urethra—patches which correspond to points where the inflammation has remained sluggish and has resisted treatment. Where lesions resembling in some degree true granulations exist, the inflammation has always extended beneath the mucous membrane, and these lesions therefore occupy the middle place between the superficial and the deep group.

The deeper changes, those of the connective tissue, are by far the most important. Of these, the most common and the most far-reaching are the periglandular infiltrations, where the bacteria have broken through the lining membrane of the follicles and have invaded the connective tissue, and where, in consequence, as the process subsides, the round-cell infiltration gives place to new-formed connective tissue which in turn produces scars. This is the basis of stricture, a lesion of far-reaching importance. In many instances these scars may be confined to the region immediately surrounding the follicles and so localized that they are more properly regarded as instances of folliculitis than of stricture. Where the process has extended more widely and the connective-tissue changes have covered a sufficient area to form a scar which, when it contracts, will affect the calibre of the urethra, organic stricture may be said to have begun. These infiltrations are particularly liable to affect certain regions of the urethra, doubtless largely because of the greater number of glands in these regions and also for mechanical reasons. Thus, the region of the fossa navicularis, and particularly the area just behind it, are not uncommonly affected. The region of the peno-scrotal angle is commonly at fault; here not so much on account of the number of glands as because the conformation of the urethra at this point produces stagnation of discharge and favors burrowing of pus. The worst region of all is the bulb, and here both the number of glands and the fact that it is the lowest point in the urethra (a circumstance which favors the mechanical retention of secretion) make for trouble.

Small excrescences of the mucous membrane (polypi or papillomata) are a rare result of chronic urethritis and, when they exist, they serve to perpetuate the process.

In general, chronic anterior urethritis is much less common than chronic posterior urethritis, the German school to the contrary notwithstanding. The accessibility of this portion of the urethra and the comparatively superficial position of the glands make its treatment easy and its cure more certain, except in cases in which a stricture of the urethra exists.

Symptoms.—In the great majority of cases there are no symptoms and the process declares itself only by two signs, which, as they do not seriously incommode the patient, are liable to be overlooked and neglected. These signs are: a slight discharge most marked in the morning, and the presence of shreds in the urine. These discharges may be grouped under that all-embracing and rather pernicious term—gleet. They vary from a slight, thick purulent discharge, appearing at the meatus, to a slight, sticky, whitish, or glycerin-like effusion, or even to a still thinner, more watery discharge. The variation is due to the character of the process, the more purulent one usually appearing earlier and showing more marked activity of round-cell infiltration, while the others are a result of a chronic residual catarrh, characteristic of mucous membranes. At times, slight pain of a neuralgic type, slight irritation on the passage of urine, or slight itching may be experienced, but were these symptoms more common the process would be less neglected.

In all varieties of chronic urethritis there are shreds in the urine. If the process is confined to the anterior urethra, these shreds occur exclusively in the first portion of the urine. Clearness of the second portion must not, however, be held to acquit the posterior urethra, as a clear second urine is not uncommonly found with extensive damage to this portion. When the anterior process is still somewhat subacute, the first urine may be cloudy or turbid, largely owing to the presence of mucus, and in this turbid urine the shreds are seen floating. This turbidity shows both a more recent and a more diffuse process, though still confined to the anterior urethra.

Diagnosis.—It should be constantly borne in mind that in many, perhaps in most cases, there is nothing in the symptoms to distinguish chronic anterior from chronic posterior urethritis. The urine is a very uncertain guide. The shape, consistency, and size of the shreds may convey to the expert information from which he is entitled to form an opinion; but the more I see of these shreds the less certain I feel of their origin, and a comprehensive discussion of the possibilities is here out of place.

Two questions of importance need to be decided :—First, what portion of the urethra is involved, and what is the nature of the lesions; and, second, is the process still due to the gonococcus? Of the methods of search for, and the means of indentifying, the gonococcus in chronic urethritis, I shall deal more fully under the heading, The Cure of Gonorrhœa, and I will not, therefore, discuss it here.

Methods of Localizing the Seat of the Disease.—The patient should first be instructed to pass his water into two glasses. If the second glass is free from abnormal constituents, we may infer that the process is either confined to the anterior urethra or that, if the posterior urethra is involved, the amount of secretion is small—that is, not enough to flow backward into the bladder. If the second urine be cloudy or contain shreds, the diagnosis of posterior inflammation may be made with considerable certainty. In order to make still more sure that the disease is confined to the anterior urethra, it is necessary by some method either to remove the secretion from the anterior urethra after it has been allowed to accumulate for several hours, or to color the secretion in this region in such a manner that it can be readily identified. The patient is therefore instructed to return upon the next day and not to empty his bladder for some hours before the visit. The whole anterior portion of the canal, including the bulb, is then irrigated—preferably, I believe, with a small catheter and a syringe until the wash water returns clear. As it is not always easy to be sure that the irrigation is absolutely complete, without using a degree of force which might possibly overcome the resistance of the cut-off muscle, it is better to irrigate with some solution which will color any remaining shreds and thus render them less liable to be overlooked. I ordinarily employ a solution of potassium permanganate (1 : 2,500) and this technique has given good results in my hands. If, after this irrigation, the patient empties his bladder, any abnormal constituents in the urine must come from behind the triangular ligament.

Another satisfactory method is to inject into the anterior urethra some solution which will deeply color the shreds, and thus allow them to be picked out from those coming from behind. For this purpose a solution of zinc permanganate (1 : 500) may be used. This should be injected into the anterior urethra with a small injection syringe, and should be retained for about half a minute. Another solution, perhaps equally satisfactory, is methylene blue, though I have had no experience with its use. After the secretion of the anterior urethra has been dyed, the patient empties his bladder and the presence of unstained shreds may be ascertained. This method is not as accurate as the one previously described.

The process thus having been narrowed down to the anterior urethra it becomes important to know how much of the urethra is involved and in what particular part of the canal the trouble lies. For this a more exact and far-reaching examination must be undertaken, generally at a subsequent visit. Some further information, however, can be obtained by the introduction of a bougie-à-boule. A bougie is selected which will readily pass the meatus and this is slid gently along the urethra to the bulb. If at certain points the patient complains of pain it is fair to presume that the process is here most active. In general, I object to instrumental examination of the urethra except after the administration of urinary antiseptics, and for this purpose the balsams, preferably oil of sandal wood, are superior to urotropin. It is wiser to put the patient upon antiseptics and allow him to return in a few days for a more thorough examination.

This examination should include a search for stricture of the anterior urethra, for inflamed follicles, and for patches or areas of congestion, sometimes called granulations. The examination for stricture will be fully described under that heading.

The presence of follicles is best demonstrated by the introduction, into the urethra, of a sound as large as the meatus will take comfortably. This should not be passed beyond the bulb. Careful palpation of the whole anterior urethra upon this sound will show the presence of little shot-like bodies or even larger swellings, if follicles exist, though it is by no means always easy to be sure of those on the roof of the canal. Areas of thickened tissue or of undue sensitiveness along the canal can also be made out. Follicles may be found in any portion of the canal, commonly in the first inch, at the peno-scrotal angle, and chiefly in the bulb. Areas of residual infiltration are most common at the peno-scrotal angle and in the bulb.

Lastly comes the examination with the urethroscope. This method of examination is most attractive, particularly to those who have never used it, because it allows direct visual inspection of the whole anterior urethra. In practice, however, its beauties pale somewhat, for it is really difficult to decide the exact character of what is seen, and the text-book descriptions of loss of polish on the surface, of reddened mouths of ducts and areas of granulations, are surprisingly hard to reconcile with the clinical appearances. The method is preeminently one which belongs to the trained specialist, and the occasional urethroscopist will use his impressive apparatus more for its effect upon the patient's mind than for any real benefit which it may confer upon his disease. Believing, as I do, that urethroscopy is of value only to the expert, no extended description of technique will be here given.

Urethroscopy became satisfactory only with the introduction of the incandescent "cold" lamp. There can now be obtained a great variety of instruments, any one of which is satisfactory, and in all of them the fundamental element is a straight tube carrying in its wall a small electric light. This light, situated at the tip of the instrument, gives excellent illumination of the field. With this instrument the expert can detect very minute changes in the surface of the urethra or follicles from which a minute drop of pus can be expressed. Bluish congested areas may be seen; stiffening of the wall by connective-tissue changes can be appreciated by the way in which the urethra folds itself over the end of the instrument; and the position and character of the lesions can be accurately determined. Of still greater importance than the determination of these different pathological conditions is the opportunity which the instrument affords of making direct application to the damaged areas; but this more properly belongs under Treatment.

Chronic Gonorrhœal Posterior Urethritis.—Posterior urethritis is inflammation of that portion of the canal which extends from the anterior face of the triangular ligament to the bladder face of the urethra. For practical purposes the membranous portion is rarely involved in the inflammation, except in so far as it represents an extension of an active process in the bulb or in the prostate. Inflammation of the membranous urethra is probably always secondary to inflammation either in front of or behind that region and is therefore correspondingly unimportant. This is probably due, not, as has been held, to the absence of glandular structures, for they are present in ample numbers, but to the fact that it is a narrow portion of the canal, fiercely swept by the current at each urination, and to the further fact that, the glandular structures being superficially situated, the inflammation finds a much more ready foothold in the prostate or in the bulb. *In frequency and importance, chronic posterior urethritis quite overshadows chronic anterior urethritis, except when this part of the canal is the seat of a stricture. Chronic urethritis is generally posterior urethritis, and the explanation of this lies in the fact that the prostate enters into the formation of the posterior urethra.* The prostatic urethra is a canal running through a glandular organ with a thousand ducts. Once infection of the posterior urethra occurs, infection of the prostate becomes almost certain, and the number, length, and ramifications of the ducts and glands render the process particularly liable to become chronic. *If it were generally believed that the essential lesion in chronic gonorrhœa is posterior urethritis, and if treatment were based upon this belief, much good would result, even though the proposition is not scientifically accurate.*

Chronic posterior urethritis covers four more or less important conditions:—(1) Catarrhal urethritis; (2) catarrhal prostatitis; (3) chronic parenchymatous prostatitis; and (4) chronic seminal vesiculitis. Just as in anterior urethritis, we have to deal here with a superficial and a deep group of lesions; and again, as in the former condition, the superficial conditions are relatively curable and unimportant, while the deep lesions are stubborn and resistant to treatment and constitute the real crux of the trouble. To the superficial group belong chronic catarrhal urethritis and chronic catarrhal prostatitis. Theoretically, the chronic catarrhal urethritis is an inflammation confined to the mucous membrane of the posterior urethra. It extends little, if at all, into the ducts and glands; and, though its existence is an anatomical possibility, it probably occurs only in rare instances and is then likely to recover under the mildest measures. Chronic catarrhal prostatitis in its mildest forms should probably be classified with the superficial group of lesions, but it is so intimately bound up with the deeper lesions of the prostate that the diagnosis is one of great difficulty and always open to doubt. For practical purposes it is better to group all cases of chronic prostatitis together, rather than to undertake to state under what circumstances the process is confined exclusively to the lining membrane of the ducts.

Symptoms.—Chronic catarrhal posterior urethritis has practically no symptoms. The second urine may or may not contain shreds. Probably in the majority of cases which show many shreds or clouding of the second urine, the process belongs to the deeper group. The slight discharge is often due to the remaining lesions in the anterior urethra and is in no way essential to the diagnosis. There may be slight frequency of urination or slight urgency. Upon rectal examination the prostate shows no changes perceptible to the examining finger.

Diagnosis.—The diagnosis is to be made by the demonstration of shreds after careful washing of the anterior urethra; such demonstration necessarily convicting the posterior urethra of being the seat of some lesion. The posterior portion should then be carefully irrigated and the bladder completely filled, preferably with boric-acid or salt solution to prevent irritation. The patient then again washes the posterior urethra by emptying the bladder. The bladder should then a second time be distended with about six ounces of the solution and the prostate massaged. If, when the bladder is again emptied, any abnormal constituents are found, the presumption is that the prostate is involved. If the solution from the bladder contains shreds in which pus and mucus are found, some inflammation of the prostate is present, and it may be possible to decide, from the small amount of the secretion, that the process is confined to the superficial portions of the glands. The conclusion, however, may be always open to doubt, as it is by no means possible completely to empty the glands and ducts by massage.

Chronic Parenchymatous Prostatitis.—Chronic parenchymatous prostatitis may be regarded as the common form of prostatitis. Not only are the ducts and glands the site of the inflammation, but the periglandular connective tissue is involved, and round-cell infiltration has taken place and is either still present or is represented by its results, which are recognizable in the form of connective-tissue changes. In many of the more marked cases there exist small abscesses, more or less cut off from the ducts or glands from which they originated, and these abscesses constitute the most difficult part of the condition which the surgeon has to treat. In severe types of the disease the gland may be literally honeycombed with miliary abscesses and small areas of necrosis, and it is almost inconceivable that anything short of total prostatectomy will result in permanent cure. This is unquestionably the most important lesion of posterior urethritis. The frequence with which it occurs can be stated only approximately, as observers vary widely in their estimates. Thus Bierhoff, in 299 cases of posterior urethritis, found chronic prostatitis present, in some form, in 100 per cent. Frank in a similar examination of 210 cases found it present in 100 per cent. On the other hand, Hannig, in an examination of 2,009 cases of chronic posterior urethritis, found prostatitis in only 56.8 per cent. Such variations can be explained only by the differences in the character of the material seen by individual observers, by the differences in the technique employed, and by that most potent cause of variation in statistics—the personality of the observer. *It has already been suggested that, for practical purposes, chronic gonorrhœa is chronic posterior urethritis, and in the same way chronic posterior urethritis is chronic prostatitis.*

Symptoms and Signs.—In many cases the symptoms are nothing more than those of a moderate posterior urethritis. There is, however, a well-marked tendency to relapse whenever treatment is suspended or whenever the patient indulges in the least indiscretion in diet or in other ways; and the entire failure of treatment to produce lasting effect should always suggest prostatic involvement. In many cases there is more or less pain or discomfort in the perineum; frequently also there is a feeling of weight or uneasiness in the rectum when the patient sits down; or there are neuralgic pains in the region of the perineum, groin, back, or hip. Moderate frequency and urgency of urination are common. On examination the urine is likely to be turbid in both portions, though in the milder cases the second portion may be clear, with or without shreds. In the more severe cases there may be distinct increase in the amount of pus which appears at the very end of urination, when the contraction of the muscles surrounding the prostate and the neck of the bladder squeezes out the pus from the ducts and glands. This is particularly likely to be the case when the condition is the legacy of a prostatic abscess which has incompletely drained. Examination by rectum will always show changes in the size, shape, or consistency of the prostate. In the mildest cases there is little enlargement, but the examining finger encounters distinct areas of infiltration and parts of the prostate which feel soft and boggy.

In the more marked cases the prostate may be very considerably enlarged, generally more upon one side than upon the other. Changes in consistency are here the rule, and tenderness in some degree is generally present, the amount depending upon the acuteness and extent of the process and the sensibility of the patient. The seminal vesicles may or may not be abnormally distended. Where the connective-tissue changes in the prostate are sufficient to produce pressure on the ejaculatory ducts, retention of secretion in the seminal vesicles occurs, and as a result they will be found distended. Where changes in the prostate, though equally extensive, are so placed as not to obstruct the ducts, no such distention occurs. This distention of the vesicles is entirely secondary to the condition of the prostate and should not be confused with the inflammatory changes in the vesicles, which are next to be discussed.

Chronic Seminal Vesiculitis or Spermatocystitis. This is closely related to the parenchymatous form of chronic prostatitis. It may follow upon acute prostatitis, but generally, as in chronic prostatitis, it is—if one may so term it—chronic from the start. It is probably always present in some degree where there has been epididymitis, and is likely to be the source of supply in those cases of recurring epididymitis the origin of which is often obscure. Its relative frequency cannot at present be estimated with any accuracy, as the methods of diagnosis necessary clearly to establish its presence have not been carried out in a sufficiently large series of cases to warrant accurate conclusions.

SYMPTOMS.—In many cases there are no symptoms which will differentiate chronic seminal vesiculitis from chronic posterior urethritis or from chronic prostatitis. Its presence has been frequently overlooked. The most characteristic symptom is pain, generally of a neuralgic type, occurring sometimes in the testicle, frequently in the lumbar region of the back, less commonly in the groin and in the hip. In the latter region it has given rise to the erroneous diagnosis of hip disease, and when it occurs it is said to be pathognomonic, but its frequency is not such as to render it a very important symptom. Recurring, unexplained exacerbations of prostatitis should always attract attention, as they point clearly to some overlooked source of reinfection which, though it may be in the prostate itself, is also frequently in the seminal vesicles. Recurring attacks of epididymitis are always suspicious and call for careful investigation. A very characteristic though by no means common manifestation of the disease is to be found in certain changes in the secretion evacuated from the vesicles. Thus hæmospermia and pyospermia are diagnostic. In the former case the sperm is reddish, brownish, or chocolate-colored, and in the latter it is yellowish or greenish from the admixture of the pus. Emptying of the vesicle under these conditions is almost always accompanied by pain, but this may also occur in inflammatory conditions of the prostate involving the ejaculatory ducts. A great variety of symptoms referable to the sexual apparatus are also closely bound up with these conditions and are grouped in a general way under that much-abused term sexual neurasthenia. This term should clearly be reserved for those cases which show an entire absence of organic lesions and in which the symptoms are purely subjective. Impotence and every degree of change in sexual desire and efficiency may be present, and in some cases are clearly dependent upon pathological changes in the vesicles. A more extended discussion seems out of place here.

DIAGNOSIS OF CHRONIC PROSTATITIS AND SEMINAL VESICULITIS.—A study of the symptoms and the condition of the urine, and the results of localization by washing without massage, will not lead to a correct diagnosis. Examination of the prostate by way of the rectum and the results of properly conducted massage are the two methods of value. It is not generally wise to make a searching examination at the first visit, and, as has already been suggested, it is better to confine one's efforts to deciding whether or not the posterior urethra is involved, and whether or not the prostate and its appendages are to some extent to blame. (Gentle rectal palpation will suffice for the latter.) At the next visit, after the proper administration of urinary antiseptics, the patient is allowed to empty his bladder and the whole urethra and bladder are carefully irrigated. The bladder should then be distended with six or eight ounces of a mild solution, preferably of boric acid, and the prostate may then be carefully examined. It is best first to pass the examining finger carefully over the whole region of the prostate and vesicles in order to get a general idea of their size, shape, and relations. The prostate is then massaged, care being taken not to exert too much pressure for fear of lighting up some smouldering process. This massage should consist in stroking the prostate from above downward and inward, particular attention being paid to the upper and outer quadrants. It is frequently possible to appreciate distinct changes in the size and consistency of the prostate during the massage. The patient is now allowed to empty the bladder and all abnormal elements found in the fluid must come from the prostate, provided always that care has been taken to avoid pressure upon the vesicle or ampulla of the vas. The normal prostatic secretion, when mixed with the wash water, should present only a pearly opalescent appearance. A few shreds or threads of mucus and a moderate number of desquamated epithelial cells are within normal limits. The presence of pus or bacteria, especially in any considerable amount, at once convicts the prostate of inflammatory changes. Careful search through the pus thus obtained will frequently be rewarded by the discovery of gonococci and it is in these residual cases that this search is most important, particularly in the endeavor to establish the presence or absence of active infection.

The examination thus far has taken no account of the seminal vesicles. In their normal condition when collapsed the vesicles can hardly be felt. When distended or thickened they may be felt as soft, rounded, slightly pear-shaped bodies, extending upward and outward from either cornu of the prostate. When distended the upper extremity is frequently beyond the reach of the examining finger, though with the patient in the proper position, and with the perineum pushed forward while at the same time counter-pressure is made over the bladder, it is frequently possible to reach all but the tip of the vesicle. If it is desired to obtain an accurate idea of the contents of the vesicle they must be expressed only after the urethra has been thoroughly washed and the prostate efficiently emptied. The bladder is then again distended and the contents of the vesicle are squeezed out by moderate pressure exerted from above downward and inward. If the vesicle is inflamed, there is considerable danger of using too much force and lighting up a process which nature has walled off. Where there is much sensitiveness over the vesicle and it feels stiff and indurated, gentleness is imperatively indicated. It is better only partly to empty the vesicle and then to resume the task at some subsequent visit than to take any chances of lighting up infection. A surprising quantity of material, occasionally amounting to two drachms, will sometimes be obtained in this way. It should be at once collected and examined with the microscope. The presence of pus or bacteria, intimately associated with spermatozoa, epithelial detritus, and the heavy mucoid secretion of the vesicle, will lead to a diagnosis of vesiculitis. As has already been suggested in the discussion of prostatitis, it often happens that vesicles are distended, as the result of pressure on their ducts, while they are in no way involved in the inflammation. The expert examining finger may perhaps be able to tell, by the sensation which the empty vesicle conveys to it, whether or not it is the seat of inflammation; but an opinion thus formed is always open to doubt, and nothing short of the actual finding of pus in the expressed contents will certainly convict of inflammation. The normal secretion of the vesicle is a thick mucilaginous material in which are found innumerable spermatozoa, which may or may not be motile, according to the nature of the fluid with which they have come in contact or to the length of time during which they have been exposed to the air before being examined. Some portion of the expressed contents will frequently be present at the meatus, and if collected and examined at once it will generally show motile spermatozoa. Some changes take place in the contents of the vesicle purely as the result of retention: the contents become thickened, whiter and more viscid, and the spermatozoa are habitually non-motile. This condition, however, does not convict of inflammation, and may and frequently does exist simply because of pressure upon the ducts. Let it be clearly understood that the actual finding of pus in the expressed contents of the vesicle, properly collected, and a clear demonstration of inflammatory thickening and induration of the vesicle, alone convict with certainty. Many distended vesicles are not inflamed; some inflamed vesicles are not distended.

TREATMENT OF CHRONIC ANTERIOR URETHRITIS AND CHRONIC POSTERIOR URETHRITIS.—*Treatment of Chronic Anterior Urethritis.*—Success in the treatment of all chronic lesions of the urethra depends directly upon accuracy of diagnosis. Time spent upon careful investigation, which will lead to a full understanding of the lesion, is time well spent.

Where the lesion is a rather diffuse catarrh or where large patches of the urethra, especially in the bulb and at the peno-serotal angle, are involved, the disease may be treated as described above under the treatment of acute urethritis by irrigation, either with a catheter and syringe or with a nozzle and reservoir. It has seemed to me that, for these particular cases, the nozzle and irrigator afford the best results. A rather better dilatation of the urethra is secured, and the fluid is therefore more searchingly applied to the folds and crypts. A solution of potassium permanganate, varying in strength from 1:3,000 to 1:1,000, answers well for purposes of irrigation. In cases showing a turbid urine this mode of treatment should be employed daily until turbidity disappears. Then the interval between the sittings may be extended to two, three, or even four days. Silver-nitrate solutions, varying in strength from 1:3,000 to 1:1,000, are particularly valuable for use as an occasional application, but they are distinctly irritating and should not be used more than once in five days. The potassium-permanganate solutions seem to have a slight though distinct tendency to produce a chronic, low-grade catarrh, which will persist as long as the solution is used, and it is therefore desirable, when this occurs, to change to some other solution or method of treatment. Protargol, in solutions of from one-half of one per cent to two per cent strength, may be very valuable at this stage, especially if used in alternation with other solutions. Sulphate of copper, in solutions of from 1:500 to 1:100, is occasionally valuable for its astringent properties.

As the diffuse process subsides and the inflammation is limited to a few well-circumscribed patches, the endoscope may be used to advantage. For direct application much stronger solutions can be used, as they do not irritate the sound as well as the diseased mucous membrane. Thus, a silver-nitrate solution, of the strength of one per cent, may be used to advantage, care being taken to remove the excess of fluid. This type of lesion usually presents no difficulty, and, when it is found to be resistant, it is generally because the real difficulty has been overlooked. Enlarged follicles may be treated through the endoscope, either by incision or by means of injections with a capillary syringe. Where they are numerous and small this method is not always satisfactory, and, in certain cases, I have thought that some advantage resulted from massage upon a sound of sufficient diameter to distend the urethra slightly. This should always be followed by an irrigation. Patches of infiltration involving the submucous connective tissue and producing a certain degree of stiffening of portions of the urethra, are best treated by dilatation. This should be done with a steel sound, one being selected which will comfortably fill but not overstretch the urethra. In manipulating this instrument, nothing is to be gained by haste, and, if bleeding even of the most trivial amount results, more harm than good will follow. Various French observers have obtained good results by massage of the urethra upon a sound, and it is reasonable to expect that, if properly used, this procedure will be of value. The benefit of such dilatation comes from emptying the crypts and follicles and allowing the fluid used in the irrigation, which should always follow, somewhat better access to the diseased portions.

Stricture of the urethra, the most important lesion of chronic anterior urethritis, will be treated under a separate heading.

It is probable that the epithelial changes referred to above, in which the type of cell lining the urethra is distinctly changed, rarely take place, except when the submucous connective tissue is to some extent involved. Treatment should aim at the destruction of the newly formed epithelium, while encouraging at the same time the surrounding cells to reproduce the original epithelium. This is done, if at all, by the application of rather strong caustic solutions, and for this purpose silver nitrate is perhaps as valuable a remedial agent as any that we possess. Ointments should be of value for this purpose, but thus far they have not given very satisfactory results. A recent suggestion made by Young, of Baltimore, that their failure has been due to the use of an improper base, and that if made with lanolin they will be found effective, is worthy of more extended trial. He advises the use of ointments containing silver nitrate, salicylic acid, carbolic acid, and iodoform, and a very limited experience with these ointments has inclined me to give them a more extended trial. His ointment applicator is well suited to the work.

In summing up I may say that failure to obtain good results in the treatment of chronic anterior urethritis (apart from the complication of stricture) is generally due to errors of diagnosis. It will frequently be found that a source of reinfection in the posterior urethra has been overlooked.

Treatment of Chronic Posterior Urethritis.—If accuracy of diagnosis is important in the treatment of chronic anterior urethritis it is even more so in the treatment of chronic posterior urethritis. Here treatment is almost futile in the absence of accurate knowledge, and many failures are due to treatment based upon inaccurate or hasty conclusions. If the lesion is purely a posterior urethritis,—that is to say, a lesion belonging to the superficial group,—irrigations and instillations will cure. Here, in contradistinction to the experience gained in the treatment of the anterior urethra, the catheter seems more valuable than the irrigator. In many cases the forcing of the cut-off muscle is by no means an easy or an entirely safe task, though in skilled hands it can always be accomplished. The excellent results obtained by many authorities from the use of irrigation with a nozzle and reservoir have failed to convince me that it is a really safe method.

The solutions to be used are practically the same as those which have proved valuable in the treatment of the anterior urethra. Sulphate of copper, for some reason, seems to act better here than in front of the cut-off muscle. Instillations of very small quantities (not exceeding 10 drops) of the stronger solutions, accurately placed upon the posterior urethra by means of a metal syringe of the Keyes or Ultzmann type, are of value. The most generally useful solution is one of silver nitrate, in a strength varying from 1:500 to 1:100. The syringe should be inserted until its tip lies just within the triangular ligament; then the piston is depressed and a small quantity (from 5 to 10 drops) of the solution is allowed to trickle into the posterior urethra. This is promptly followed by rather sharp burning and an imperative desire to urinate—symptoms which quiet down in from two to four or five hours. The procedure is very disagreeable to the patient and its use should be limited to those cases in which distinct catarrh of the mucous membrane is evident, especially those in which a little teasing frequency of micturition exists. In the absence of distinct prostatic lesions a direct application to the posterior urethra through the posterior urethroscope, as recently advised by Swinburne, has attractive possibilities. The instrument, however, is one which may well do damage in the hands of the inexpert, and will prove useful only to those who are really familiar with urethral instrumentation.

The use of sounds in the posterior urethra, for the relief of chronic gonorrhœal lesions, has been abused, and probably more harm than good has resulted. They are of some value when the lesion is of the superficial type, for the same reason that was given in the section relating to lesions of the anterior urethra. Overstretching does harm, insufficient stretching does no good. The use of sounds, therefore, requires an accurate diagnosis and delicacy and skill in their manipulation. The use of these instruments by unskilled practitioners is not to be advised.

Treatment of Chronic Prostatitis and Vesiculitis.—The mainstay in the treatment of these lesions is massage, effectively seconded by rectal irrigations.

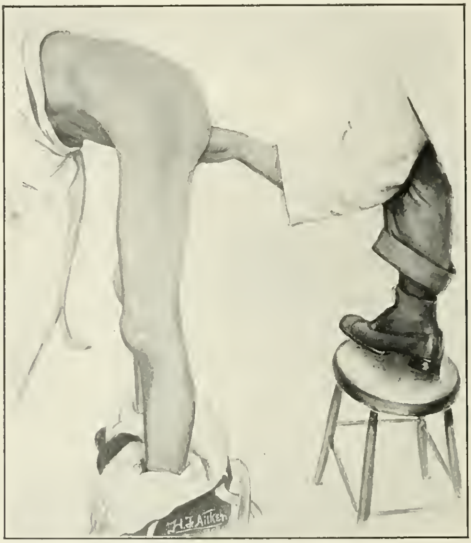


FIG. 525. Technique of Massage of the Prostate. The illustration shows the position of the hand, forearm, and knee of the surgeon in relation to the patient.

They are of value in all conditions of the prostate and vesicle, excepting acute inflammation, when massage must be used with extreme caution and rectal irrigations should be given the first place. Fuller, in his book published in 1894, did a distinct service in calling attention to the value and methods of the use of massage.

Technique of Massage.—It is always better to massage the prostate and vesicles with a partially distended bladder; and it is preferable that the distention should be effected with some slightly antiseptic fluid and not with the urine. The patient should empty his bladder and the anterior urethra should be efficiently irrigated. The bladder is then filled with six or eight ounces of boric-acid solution. The patient should stand upon the floor and lean forward, bending only at the hips, over a table or the back of a chair. The index finger protected by a finger cot is then inserted into the rectum, the finger and forearm being kept in line. Pressure upon the perineum may be more effectively made if the surgeon places his foot upon the seat of a chair, so that his knee presses against his elbow. In this way a considerably greater reach is obtained. (Figs. 525 and 526.)

After the region has been carefully explored with the examining finger the prostate is massaged, from above downward and inward, with moderately firm pressure. A beginner will do well to err upon the side of gentleness; with increased knowledge comes the ability to increase the force used and thereby to increase the efficiency of the emptying process. If the vesicles are distended they should be emptied after the prostate has been massaged. Gentleness is here even more important than in massage of the prostate. Examination of the wash water from the bladder will give a good idea of the condition of the prostate. If the prostate has been massaged without washing or distending the bladder, irrigation of the whole urethra should always follow. Occasional sharp infection of the urethra results from failure to observe this precaution.

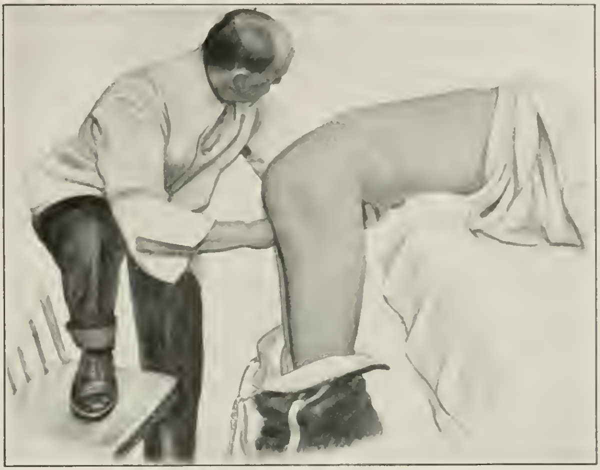


FIG. 526. Technique of Massage of the Prostate. The illustration shows the relative positions of the surgeon and the patient useful in making massage efficient.

Rectal Irrigations.—These are given, as already suggested under Acute Prostatitis, with a tube of the Kemp or Chetwood type. In chronic conditions irrigation night and morning is always sufficient and once a day will frequently be enough. The amount of water used should not be less than four quarts and should be allowed to run slowly so as to produce the maximum effect. Most patients readily learn to carry out this procedure for themselves. It may be done either in a recumbent or in a sitting position and the patient may select the method which best suits his convenience. Occasionally a patient will be seen who is naturally so clumsy that it will not be practicable for him to carry out the procedure. Such individuals, fortunately, are rare.

Sounds and Dilators.—The best that can be said for these instruments, so far as chronic prostatitis is concerned, is that, if carefully used, they may not do harm. If roughly or frequently used, however, they may and frequently do inflict much damage, and, except when the process is not gonorrhœal, they almost never do good. As above stated, they may exert some beneficial influence upon the mucous membrane of the posterior urethra. Sounds are of great value in strictures which invade the membranous urethra, and they are useful in contracture of the neck of the bladder, but in true gonorrhœal prostatitis their use is to be discouraged.

The most important element in the cure of prostatitis is time. The more acute cases may be treated every two or three days, but it is rarely wise to massage the prostate more than once in four days;—once in five days is a good working rule. At the intervening visit irrigations or instillations may be used. As the process quiets down, the interval between visits may be extended up to once a week, but, until the process is nearly well, visits at longer intervals will serve only to prevent a relapse.

While local treatment is being carried out, the general condition of the patient should receive attention, for anything which tends to produce a poor general condition will influence the local disorders unfavorably. Regular habits, particularly in regard to food and exercise, are important. Tonics are often valuable. Horseback riding and bicycle riding during the subacute stages are always bad. In the later stages of the more chronic process they are often not harmful and may even occasionally prove beneficial. It will frequently be found that a cure is not obtainable in less than a year, and I am well satisfied to get it in eight months. In some of the most stubborn cases the mere stopping of all treatment (except the tonics), in conjunction with a complete change of scene,—as may be obtained, for example, from a sea voyage,—will frequently succeed where all other measures fail. I believe that there are occasional neglected cases which must be pronounced incurable, though continuous well-planned treatment may succeed in preventing acute exacerbations.

Prostatectomy.—In some cases, particularly those in which a markedly indurated prostate is associated with the constant presence of residual urine in the bladder, and in which the usual methods of treatment produce no effect, the operation of prostatectomy must receive careful consideration. Young has recently called attention to these cases and he reports good results from the operation. In many instances, however, the operation, even when performed in the most skilful manner, must result in sterility. It should be reserved for those cases in which there is obstruction to the complete emptying of the bladder, and in which therefore the development of pyelitis and pyelonephritis may in time be confidently expected. To avoid these serious dangers this rather radical operation becomes the lesser danger of the two. (See the article on "Surgery of the Bladder" in Vol. VIII.)

There is also a class of subacute cases in which Alexander has shown that the prostate is riddled with numerous small abscesses. In such cases nothing short of prostatectomy will effect a cure; but the selection of these cases, in the light of our present knowledge, is extremely difficult.

Contracture of the Neck of the Bladder.—Some of the most chronic of these cases of prostatitis go on to a condition of contracture of the structures surrounding the neck of the bladder, a condition which has long been known, but which, as Keyes has pointed out, seems to have been considerably neglected. The symptoms closely resemble those of enlargement of the prostate, though the prostate is not enlarged. There are generally pain, always frequency of urination, always some residual urine, and frequently evidences of infection of the upper urinary tract. These cases do not yield to dilatation with sounds; they require perineal section, with division of the bladder neck by means of a cautery, according to Chetwood's method, or prostatectomy as suggested by Young. Prostatectomy in these cases in an exceedingly difficult operation: enucleation does not seem to be practicable, and consequently the prostate must be removed by nibbling and biting it away piece by piece. After this sort of operation it is extremely probable that some obstruction will remain. There is no class of cases in which prostatectomy is more difficult.

IV. THE CURE OF GONORRHŒA.

The decision, in this far-reaching disease, that a genuine cure has been effected, is, from the point of view of the community at least, a matter of the greatest importance. While it is unquestionably true that the patient is more interested in the relief of symptoms than in the establishment of a cure that will stand the tests of the bacteriologist, it is far more important that he should cease to be a menace to the community than that he should be free from symptoms. Modern opinion, both professional and lay, is beginning to appreciate the importance of accuracy in this regard, but it is undoubtedly a fact that in the past the decision that a cure has been effected has been too hastily reached; and, as a result, the patient has been allowed to disseminate his disease with the most disastrous consequences. Relatively few practitioners are qualified to decide whether a patient who has had gonorrhœa is cured or not. In many cases the diagnosis is surrounded with great difficulties and can be surely made only by the combination of a skilled clinician with a bacteriologist who is familiar not only with the subject in general but with the peculiarities of the gonococcus.

In regard to the possibility of securing a cure two extreme views are frequently expressed: according to one of these—the view more commonly held by Continental observers—a person once infected is always infected: according to the other—the view which is more likely to be held by the light-hearted general practitioner—it is safe to consider a complete subsidence of symptoms and freedom from recurrence as a cure. Whatever may be the truth, it must be generally admitted that the vast majority of patients infected with the gonococcus become free from symptoms, have no return when all treatment is omitted, and later marry and have children without disastrous consequences. On the other hand, it is equally certain that in many patients, especially those who have been subject to several attacks, the disease is only quiescent. The patient is immune to the particular strain of cocci which he harbors and they cease to have power to infect him, though retaining ample ability to endanger others. Somewhere, therefore, between these two extreme views there lies a position which may properly be taken by the conscientious practitioner,—*viz.*, that, certain searching tests having been made, he may properly declare the patient free from the possibility of scattering infection.

For the purpose of clearness, the cases which present themselves for an opinion as to cure may be divided into three classes:

(1) Patients whose first urine is habitually cloudy or frequently cloudy and always contains a large amount of shreds, and who give a history of a marked tendency to relapse.

(2) Patients whose urine habitually contains shreds but who show no tendency to relapse without treatment and who live ordinary lives.

(3) Patients whose urine is habitually clear and free from shreds or other abnormal constituents.

Of these classes, class three, if it comes fully up to the requirement that the urine must be habitually clear,—and it is essential that the first urine passed in the morning should be examined on several occasions,—may be dismissed as cured. Class one, in the vast majority of cases, will be found to be still infected. In class two—and this class comprises a majority of all cases—some will be found to harbor germs and others to be free from infection, although the urine frequently or even habitually contains some shreds. Finger insists that, as long as pus can be found coming from any portion of the lower urinary tract, the patient must be regarded as infectious, and that only when the shreds are made up of epithelial cells can these patients be dismissed as cured. This opinion, coming from such a source, is entitled to the highest consideration; but the fact remains that many observers, whose ability and accuracy are undoubted and whose experience is large, have declared many patients free from infection who still showed shreds containing pus cells, and the accuracy of this opinion has been borne out by the subsequent immunity from trouble which these patients have enjoyed. Notwithstanding the high regard which I entertain for Finger's dictum I believe that the requirements which he mentions are too severe. The ultimate question to be decided is: Have the gonococci entirely disappeared? and I firmly believe that it is practicable, by means of searching tests, to give a positive answer to the question.

There are three methods which are commonly employed to stir up the disease when it is latent. These are: the excessive use of alcohol, sexual excitement, and the irritation of the urethra with strong chemicals. Apart from the question of morality, these methods are open to the objections that they may make a more or less well man sick, and that they are of questionable utility. As regards the moderate use of alcohol, particularly beer, I see no great objection.

The following method of examination seems to me safe. In the first place, the shreds which appear in the urine should be searchingly examined on several occasions, preferably not on successive days, and it is better to examine them once in three or four days for seven successive visits than to to examine them every day for a week. These shreds should be submitted to an examination with the microscope and at the same time cultures should be made. The secretion of the prostate and vesicles should be submitted to the same test and should be obtained directly from the meatus or from the wash water that escapes from the bladder, salt solutions being used instead of any antiseptic fluid. If any patches of stiffening are found in the urethra and if the canal manifests any tendency to narrowing, some of the secretion from these regions should be subjected to an examination. The examinations, which should be entrusted to a person who is really familiar with the peculiarities of the gonococcus, should be made with sufficient frequency to leave no doubt that they represent a fair view of the facts. One positive finding of the gonococcus condemns. Many negative findings should be insisted upon before the patient is declared not guilty.

V. STRICTURE OF THE URETHRA.

In the past the term stricture has been used to cover a wider range of conditions than modern opinion will sanction, and there is a growing tendency to limit its employment to what used to be called organic stricture. As formerly used the term covered, not only all narrowing of the canal, whether arising from within or from without, but certain conditions in which no true stricture exists and in which the canal is not, properly speaking, narrowed. For the purpose of clearness conditions other than organic stricture will be briefly described.

Non-Organic Strictures.—*Spasmodic Stricture.*—This is not, properly speaking, a stricture at all, but a neurosis giving rise to one symptom of stricture, namely, retention of urine. There is no obstruction of the canal and in many cases instruments pass without difficulty, while in other cases spasmodic contraction of the muscles about the membranous urethra may to some extent interfere with the passing of the instruments. There is never any gripping of the instrument as it is withdrawn,—a constant and characteristic symptom of organic stricture. There is also a form of so-called spasmodic stricture which is due to the presence, in the anterior urethra, of patches of inflammation remaining after an acute urethritis. These patches are abnormally sensitive, and when they are irritated by instrumentation muscular spasm is apt to occur. In these cases there are no symptoms of stricture and the condition is discovered only during the search for the cause of a chronic urethritis. The passage of instruments may be definitely obstructed, but there is not gripping and the condition is one of pure spasm.

DIAGNOSIS.—Pure spasmodic stricture is a neurosis and may arise reflexly after an operation—such, for example, as an operation for hernia, for hemorrhoids, etc.;—or it may come on spontaneously in patients with a neurotic tendency, and is then generally an evidence of fatigue. The diagnosis presents no difficulty, as there is either no obstruction at all to the passage of instruments, or, if any such is encountered, it is in the membranous portion of the urethra, where organic stricture does not occur. In the other variety of so-called spasmodic stricture the diagnosis may present some difficulty, and a considerable number of cases are sent to the surgeon for operation, sometimes for impassable stricture, in which, when the patient is under the influence of an anaesthetic, a full-sized instrument passes without difficulty. It is generally possible to make a diagnosis by a careful examination of the urethra, aided if necessary by the local use of cocaine. Where doubt exists, the employment of a general anæsthetic will always settle the question.

Treatment.—The treatment of pure spasmodic stricture occurring after surgical operations consists in relieving the retention by the use of a catheter, coupled with the appropriate administration of urinary antiseptics up to the time when the reflex spasm disappears. Frequently one catherization is sufficient. In rather rare cases retention may persist until the patient is up and about. The treatment of spasmodic stricture due to sensitive patches in the anterior urethra is that of anterior urethritis.

Congenital Stricture.—Congenital stricture is due to faulty development, the separately developed portions of the urethra failing to become adjusted in their normal relation. The most common variety is that of the meatus in which there is a thin membrane obstructing the lower half of the meatus and making the opening abnormally small. The next most common variety is characterized by a narrowing at the anterior limits of the fossa navicularis, which has been aptly termed the second meatus. In this condition the urethra at this point is narrower than at the true meatus. Valve-like obstructions (which are sometimes spoken of as pre-membranous) occur in the posterior part of the bulb, and Lebreton has described such conditions at the peno-scrotal angle and in the scrotal portion of the urethra. All of these latter conditions are rare.

Symptoms.—The congenital strictures of the meatus and the fossa navicularis cause no symptoms and the possessor of these deformities lives in blissful ignorance of his condition until it is discovered by some genito-urinary surgeon who desires to introduce instruments into the canal.

Pre-membranous and penile congenital strictures are seen in children and young people in whom they cause incontinence of urine, either nocturnal or diurnal, and in rare cases retention. They are not common, but should be remembered as a cause in cases of incontinence which resist treatment.

Treatment.—Congenital strictures require treatment only when they cause symptoms. Probably in the majority of cases they are never discovered until it is necessary to pass instruments into the urethra. In the presence of congenital narrowing of the meatus meatotomy must be done. In the days when the teaching of Otis was more widely accepted and it was thought necessary to employ instruments of a very large calibre, meatotomy was performed with a frequency which to-day seems quite unnecessary. There is, however, no objection to doing the operation when there is a real indication for the passage of instruments.

Technique of Meatotomy.—A considerable number of meatotomes have been devised, but a narrow-bladed knife serves every purpose. The operation can be readily done under cocaine and a general anæsthetic is quite unnecessary. The region of the meatus and the anterior part of the fossa navicularis may be anæsthetized by placing a tablet of cocaine just within the meatus; but I prefer to cocainize the region by injecting cocaine under the mucous membrane with a hypodermic syringe. In this way the anæsthesia is more perfect and more closely confined to the region of the incision. I habitually combine adrenalin with the cocaine solution, as the absorption of the drug is thereby much delayed and any possibility of cocaine poisoning is removed. In the solution which I generally employ the two drugs are combined in the proportion of 5 drops of the adrenalin solution (1 : 1,000) to 1 drachm of a one-per-cent cocaine solution. The completeness of the anæsthesia should be tested by the point of the needle or knife before the incision is made. The cut should be made in the floor and should be accurately placed in the middle line. If only the meatus is narrowed the incision may be confined to the valve-like fold, but in most cases there is some narrowing that should be divided at a point at about half an inch or a quarter of an inch distant from the orifice of the canal. The presence of this band may be readily appreciated by the knife. The meatus should be enlarged sufficiently to admit a full-sized sound without difficulty, and it is well to remember that, as the wound heals, it will probably contract to the extent of about two sizes of the French scale. After the incision is made gauze should be packed into the wound to check the oozing which will generally occur, but which should not be excessive.

The wound should be kept freely dilated by the daily passage of sounds until cicatrization is complete. In rare instances rather sharp secondary hemorrhages occur, but they can always be checked either by packing or by the insertion of a full-sized catheter and compression of the urethra against this by a bandage. These secondary hemorrhages, if neglected, are occasionally serious.

Premembranous and penile strictures will generally yield readily to gradual dilatation; in rare cases they will require internal urethrotomy.

Organic Strictures.—An organic stricture is a loss of dilatability of any portion of the urethra. It is due to the presence of scar tissue in the submucosa or in the corpus spongiosum, and arises either from injury or from inflammation.

Traumatic Stricture.—A traumatic stricture usually results from a fall, the force coming on the perineum and crushing a portion of the urethra against the pubic bone. It is caused by a great variety of accidents, such as a fall astride a fence or chair or the spar of a vessel or into an open coal hole in the street; a kick from man or beast; striking on the pommel of a saddle; and fracture of the pelvis. More rarely, it results from the presence of a foreign body in the urethra, from a bullet wound, from a knife cut, and from the unskilful use of instruments. Except when they are due to foreign bodies, bullet wounds, and knife cuts, these strictures are practically always located in the membranous portion, a part of the urethra which is involved only secondarily in inflammatory stricture. The preponderance of strictures in the membranous part of the canal is due to the fact that this is the fixed portion of the urethra, the only portion, so to speak, which cannot get out of the way and is therefore readily caught against the bone. The resulting scar comes largely, of course, from direct violence with tissue destruction, but in part also from the irritation produced by the urine, which inevitably comes in contact with the raw surfaces and produces some infiltration. Even in the most favorable cases the condition is not, therefore, a purely traumatic scar, but is complicated by inflammatory reaction.

Inflammatory Stricture.—An inflammatory stricture is practically always the result of previous gonorrhœal urethritis. Simple urethritis, when of a severe type, syphilis, chancroid, and tuberculosis are rare causes—so rare, in fact, that they need hardly be considered.

PATHOGENESIS OF GONORRHŒAL STRICTURE.—In a gonorrhœal stricture the narrowing is due to the formation of cicatricial tissue in the submucosa and, more deeply still, in the adjoining portions of the corpus spongiosum. The facts as shown at post-mortem examinations are clear, but it is less easy to trace the conditions which produce the scars, and many theories have been evolved to account for them. The theory, often referred to as that of the Finger-Guyon school, attributes it to a chronic urethritis. This becomes untenable in the face of two well-known clinical facts, viz., first, that stricture may and frequently does occur where there has been no chronic urethritis; and, second, that chronic urethritis is generally a posterior urethritis and yet stricture does not occur in this region. Harrison advanced the view that stricture results from increased permeability of an inflamed mucous membrane to the urine—in short, that it is a slowly moving infiltration of urine. This probably accounts for part of the process, but it is hardly a sufficient explanation of its beginning, and fails to account for the tendency to localization in certain regions. The theory of Guiard ascribes it to the virulence of the infection and the length of time during which the gonococcus remains active in the urethra. This latter theory, combined with that of Harrison, seems the most logical. The more virulent the process the deeper it is likely to penetrate, thus causing a periurethritis. If a group of neighboring follicles becomes inflamed the process spreads to the submucosa, a considerable area of infiltration results, and the basis of organic stricture is laid. With this infiltration the elasticity of the urethra is lost, it fails to empty itself completely, and at each urination a few drops of urine remain behind. This urine decomposes and keeps up a chronic inflammation which perpetuates the original process. At this point the theory of Harrison becomes tenable. As the urethra stiffens the obstruction becomes more marked, the tissue is irritated by the impact of the urinary stream, irritation and spasm are increased, and a vicious circle is started. It is to be remembered, however, that the essence of the process is the primary invasion of the submucous connective tissue by the original infection.

PATHOLOGY.—*Time of Occurrence.*—As regards the rapidity with which the symptoms appear there is a sharp distinction between traumatic stricture and the stricture which follows gonorrhœa. Symptoms of obstruction following trauma come on promptly; they practically always appear during the first year and frequently within a few weeks. Thus, it is not unusual to see a case in which a tight or impassable stricture develops within six or eight weeks after an injury. Obstructions following gonorrhœa, on the other hand, are notably slow in appearing; probably the majority do not cause symptoms until after the lapse of at least two years, and it is common to find them appearing only after five or even ten years.

Number of Strictures.—Organic strictures of the urethra occur, as a rule, singly. In the case of traumatic strictures it is very exceptional to find more than one obstruction, and this is only what would be expected. Clinically, it is not unusual to encounter several gonorrhœal strictures in one urethra. This statement was made many years ago by Guyon, and is clinically correct, though not supported by pathological evidence. This apparent difference between the two kinds of evidence is in reality due to the difference between the points of view. Gonorrhœal strictures are frequently due to an inflammation which extends over a considerable area of the urethra, and the surgeon, in passing a sound, thus gains the impression that there are several strictures, because different parts of the same stricture are of different calibre and possess different degrees of irritability. Where multiple strictures are thought to exist clinically, it is the rule that the deepest stricture is the narrowest, and this fact is due to the increased irritability at the point of greatest inflammation,—an irritability which is due to the impact of the urinary stream,—and it only serves to bear out the pathological view that, as a rule, only one lesion is present. Thompson, in two hundred and seventy pathological specimens, found only forty-four cases in which there was more than one lesion.

Position of the Stricture.—A traumatic stricture, except when it is due to a bullet wound, a knife cut, or some similar form of external violence, is almost universally found in the membranous and premembranous portions of the urethra. A gonorrhœal stricture, on the other hand, may occur in any part of the urethra except the prostatic portion, though inflammation of the membranous portion is always secondary to a process in the bulb which has extended backward. It is most frequently found in the bulbar portion, the proportion being variously estimated at from sixty per cent to seventy per cent. The next most common strictures are those which are located in the region of the penoscrotal angle, including a portion of the urethra about two inches long on each side of this point. (Fig. 527.) Their frequency is stated at from ten per cent to twenty per cent. Of about equal frequency are strictures at the meatus and in the region of the fossa navicularis. Of these, however, the majority are congenital, and pure organic strictures in this region are not common, except when due to ulceration at the meatus from chancroid or syphilis.

Forms of Stricture.—Strictures may be annular, cylindrical, spiral, or irregular, the latter being the most common type. These differences are due to the irregular growth of the scar tissue, as a result of which the lumen of the canal is pushed in one direction or another and is frequently eccentric. Traumatic strictures, from the very nature of the injury inflicted, are most commonly annular, and, by the same token, gonorrhœal strictures are likely to be irregular.

Pathological Changes.—Since the essential alteration in stricture is a scar in the submucous connective tissue, the lesions of the canal will vary with the position, size, and amount of newly formed tissue. The mucous membrane in front of the stricture is, as a rule, unchanged; that behind the stricture always shows some changes. In a mild case, where the stricture is still of large calibre, there is nothing more than congestion; later, there is real inflammation. The mucous membrane may be destroyed and replaced by pavement epithelium. The glandular structures are inflamed, and their ducts are often dilated. They are frequently the seat of abscess and may be destroyed and disappear entirely. The glandular lesions are important as they give the key to the formation of periurethral abscess and fistula—a condition which is particularly to be found in the region of the bulb, where it is due to abscess of Littré's or Cowper's glands. It must not be forgotten that these periurethral abscesses, which go on to the formation of fistulæ, are in no respect peculiar to stricture of the urethra, and many of the perineal fistulæ, once held to be pathognomonic of stricture, occur from glandular suppuration when no stricture exists.

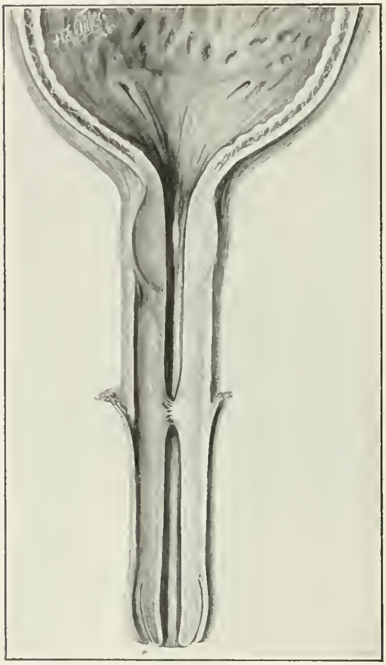


FIG. 527.—Stricture of the Urethra. Gonorrhœal stricture at the peno-scrotal angle, showing hypertrophy and trabeculation of the bladder.

Resulting and Associated Changes.—When the stricture is sufficiently narrow to produce real obstruction, the urethra behind this point is habitually dilated. Where the stricture is tight this dilatation may become extreme, and with this go the glandular infections, Cowperitis, prostatitis, and their resulting abscess and fistula. With the obstruction of the urinary stream comes the hypertrophy of the bladder muscle, and in the later stages diverticulæ may form as a result of hernia of the mucous membrane between the muscular bundles. Consequent upon the increased intravesical pressure comes dilatation of the ureters and pelves of the kidneys. (Fig. 528.) This was formerly held to be due to the incompetency of the valve-like arrangement of the lower end of the ureters. This, however, is clearly not the case; the dilatation is due to the increased resist-

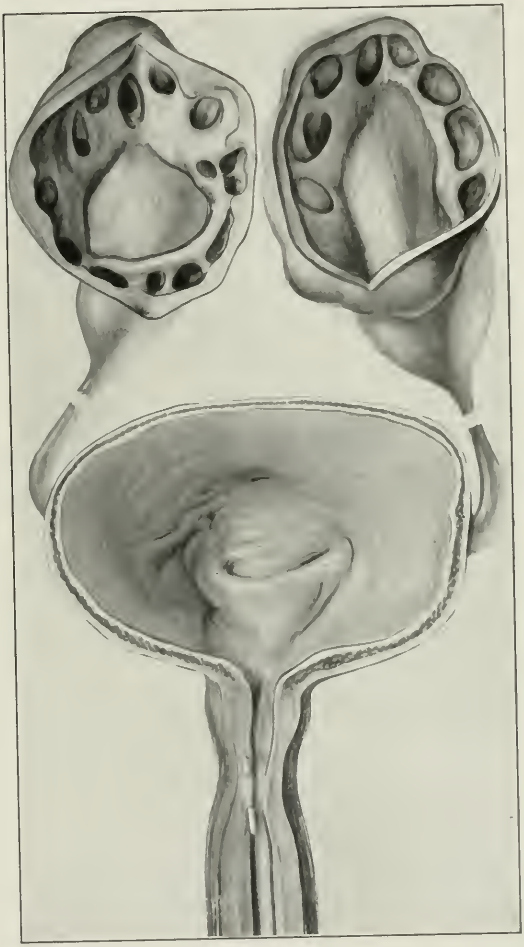


FIG. 528.—Stricture of the Urethra. Gonorrhœal stricture of the bulbo-membranous type, showing hypertrophy of the bladder, dilatation of the ureters and pelves of the kidneys, and extensive destruction of the kidneys. Note the absence of dilatation of the vesical orifices of the ureters.

ance under which the urine makes its way down the ureter The bladder end of the ureter is probably the last point to become dilated. When such a condition of affairs has resulted in a chronic congestion of the mucous membrane, the entrance of bacteria, whether by the blood stream, by migration through the tissue intervening between the bladder and the bowel, or by instrumentation, is the match in the powder magazine. At once cystitis, ureteritis, pyelitis, and pyelonephritis (surgical kidney) supervene and form the really menacing part of the disease.

SYMPTOMS.—Symptoms occur only when the narrowing has become sufficient to produce real obstruction, and thus for many years stricture may produce no symptoms and pass unnoticed. The exception to this is found in traumatic strictures where the rapid development of the lesion at once gives rise to symptoms. In many cases the symptoms are purely those of the complications following infection. In typical cases, however, certain symptoms will frequently be observed.

Changes in the Urinary Stream.—The most important alteration is in the force of the stream. Patients will frequently notice that the force has diminished, that the length of time required for emptying the bladder has increased, and that some dribbling occurs after the bladder is apparently empty. With this there is a general diminution in the size of the stream, and the patient may then be conscious of increase of effort, involving the use of the abdominal muscles. It is at this time that the urethra begins to fail to empty itself, a few drops of urine remaining behind the stricture. This is the real beginning of the worst phase of the process of chronic infiltration. Much stress has been laid upon changes in the shape of the stream, but it should be remembered that these depend entirely upon conditions at the meatus and therefore bear little relation to the essential lesion.

Gleet.—Some urethral discharge, generally slight, is a very constant symptom of stricture. It is evidence only of the accompanying urethritis of which it is a symptom rather than of stricture. This, of course, results in the habitual presence of shreds in the urine.

Frequency of Urination.—Frequency of urination is a common symptom of stricture, but it is due to the accompanying congestion of the deep urethra and prostate, or even to true prostatitis, rather than to the stricture itself. It is thus a result of the complications and shows that changes in the deep portions of the canal have occurred.

Pain.—This also is generally due to some inflammatory disturbance in the deep portion of the canal, frequently to infection. Pain on micturition is common in well-marked strictures and habitual in the later stages. Pain in the back, groin, hip, or testicle is frequently observed and is due to prostatitis.

Retention of Urine.—Retention of urine is frequently the first symptom which attracts the patient's attention to his condition. It is due to acute congestion of the mucous membrane at the point of stricture, and generally follows excess in alcohol, etc., or exposure. Chilling of the feet and legs is a common cause. It may occur long before the stricture has become tight, may be relieved by a single catheterization or spontaneously, and may continue to recur over a series of years, before the stricture finally shuts down and becomes nearly or quite impassable. It is a symptom, however, which should never be disregarded or treated lightly, as it affords conclusive evidence of stricture of the urethra or of disease of the prostate.

Sexual Symptoms.—A great variety of sexual symptoms may be associated with stricture of the urethra; they bear comparatively little relation to the severity of the condition. Thus, stricture of large calibre may produce impotence, while a comparatively tight stricture may exist without any change in sexual capacity. Impotence is the most common result, but where prostatic congestion exists sexual irritability in any of its forms may occur.

Secondary Symptoms.—As complications of stricture come cystitis, stone in the bladder, pyelitis, and all the symptoms which follow in the train of a chronic uræmia—viz., loss of appetite, slight nausea, general deterioration of health, headache, etc. Hernia and hemorrhoids not infrequently result from the straining incident to the urethral obstruction.

DIAGNOSIS.—The diagnosis of organic stricture is, in the great majority of cases, very simple, and yet there are few of the more common maladies concerning which so many mistakes occur. In any case in which the symptoms suggest the possibility of stricture, the diagnosis is to be made only after a properly conducted examination of the urethra. Such an examination should not be made—unless the symptoms are urgent, as in the case of acute retention—until after the administration of a urinary antiseptic. The only two drugs which call for special consideration here are urotropin and oil of sandal wood. Other things being equal, urotropin, in doses of 5 grains three times a day, should be administered, as a matter of routine, for at least twenty-four and, better, for forty-eight hours before examination. Where there is any considerable urethral discharge, oil of sandal wood is perhaps equally valuable as an antiseptic, and will also have some effect upon the disease. I have found it efficient in preventing the so-called urethral chill.

Methods of Examination.—The examination should be begun with a steel sound as large as the meatus will admit without difficulty. To begin with a small instrument is to expose one's self to the probability of its becoming arrested in pockets or folds and thereby giving the erroneous impression of obstruction. It not infrequently happens that a full-sized sound will pass where a small bougie will not go. If the sound passes on to the bladder without meeting with an obstruction, and can be withdrawn without being gripped by the urethral walls, no stricture exists. An exception to this rule is to be found in those cases in which the meatus is so small that it will not admit an instrument as large as 25 (French scale) and in which some narrowing may exist, although so slight as to escape detection. In these cases it may be necessary to enlarge the meatus. If the sound is arrested at any point in front of the triangular ligament, a smaller one should be selected, and the size successively decreased until one is found that will pass, or until No. 20 has been reached. Below this size it is safer to use only soft bougies, as a small sound is an engine of destruction except in the hands of the expert. Bougies of decreasing size should be passed until the filiform size is reached. If not even a filiform bougie will pass, and the patient is still able to pass urine without great difficulty, no further examination should be undertaken at this time, as the diagnosis is clear, and it is safe to postpone further investigation until a subsequent visit.

In the great majority of cases some instrument larger than the filiform will pass, and it then remains to demonstrate the position and probable length of the stricture. This is done with the olive-tipped bougie or the bougie-à-boule. A size should be selected which can be passed down to the face of the stricture, but which will not pass through. The distance from the meatus is noted, and a bougie is then chosen which will pass the stricture. As it is withdrawn, its shoulder will be caught by the posterior face of the stricture, and in this way the approximate length is determined. For strictures of large calibre the Otis urethrometer is valuable.

Sources of Confusion.—The only common sources of confusion are in the muscular spasm previously referred to under Spasmodic Strictures and in the presence of sensitive areas which resent the passage of instruments. Gentle pressure will generally overcome obstruction from spasm due to either of these causes, and true spasmodic stricture is found practically always in the membranous urethra, where organic stricture does not occur as a primary lesion. Some question may arise as to the presence of a stricture of large calibre, that is to say, larger than the calibre of the meatus. Its presence may sometimes be demonstrated by the use of the Otis urethrometer, or the meatus may be sufficiently enlarged to admit a No. 30 sound (French scale). To-day, however, surgeons are taking a rather broader view than that advanced in the teachings of Otis, and they now regard as physiological many narrowings which he regarded as strictures of large calibre. In the absence of symptoms it should not be necessary to mutilate the meatus. Spasm in any of its varieties and physiological narrowings may be distinguished from organic stricture by the absence of gripping of the instrument as it is withdrawn.

Prognosis.—It goes without saying that the prognosis of this lesion depends in general upon treatment. Left to itself organic stricture will go on contracting more or less steadily until it produces the secondary lesions of the urinary tract—lesions which, with infection added, are almost sure to terminate fatally.

On the other hand, the prognosis of organic stricture varies very much with the different varieties. Traumatic stricture forms rapidly, contracts in a short time, and soon leads to retention of urine and secondary complications. Stricture following gonorrhœal urethritis, on the other hand, forms slowly, contracts slowly as compared with traumatic stricture, and may produce no appreciable symptoms for many years. Strictures in the bulbo-membranous region contract more rapidly and cause symptoms at an earlier period than those nearer the meatus. They are also more resistant to treatment. Strictures in the region of the peno-scrotal angle form slowly, contract slowly, and are more readily cured. Strictures at the meatus, usually congenital, rarely cause any symptoms except when they are due to tissue destruction, as by chancroid. In any variety of stricture the appearance of symptoms will depend very much upon the patient's habits of life. A man of careless habits, especially if he is a hard drinker, will have symptoms earlier and of greater severity than one who, though he may have carelessly exposed himself to a urethritis, yet leads a well-ordered existence. If we except death due primarily to surgical operation, stricture proves fatal from one of three conditions:—(1) Extravasation of urine; death under these circumstances being due to sepsis. (2) Chronic uraemia, which is generally complicated by some infection of the upper urinary tract. (3) Exhaustion. In time, frequency of urination and pain will kill, but it may be years before this event takes place.

Instruments.—In order to avoid repetition, a brief description of the instruments most generally useful in the treatment of organic stricture will be given here. No attempt will be made to describe all the instruments which may be used, as they are very largely matters of personal preference, and every surgeon of large experience will have his own pet devices, which are of personal rather than general interest.

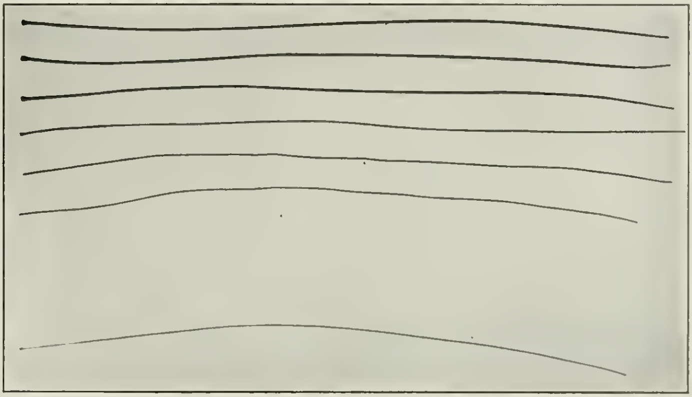


Fig. 529.—Filiform and Small Bougies.

Filiform Bougies.—Filiform bougies are the smallest instruments used in the urethra; they vary from No. 3 of the French scale to instruments no larger than the ordinary coarse silkworm gut. (Fig. 529.) They are made either of fine strips of whalebone, which generally have an olive tip, or of webbing similar to that of which the larger bougies are constructed, the best of which are of French make. The webbing bougies are generally blunt at the point and not as stiff as whalebone, but they have the advantage that they are not brittle and are therefore somewhat safer. Whalebone bougies may be softened in hot water and then bent at the point so that they may more readily enter an opening at one side of the urethra. This deviation of the point, though it is often of assistance in passing the opening of an eccentric stricture, has the disadvantage of rendering the instrument more likely to be caught in open mouths of follicles.

French filiform bougies are frequently used as guides for larger instruments. For this purpose there is attached to one end a metal screw which fits accurately into the tip of the instrument to be guided, leaving a smooth joint. These guides are most frequently used with the Maisonneuve urethrotome and with the so-called French "followers" used in dilating strictures. They may also at times advantageously be attached to the Otis urethrotome.

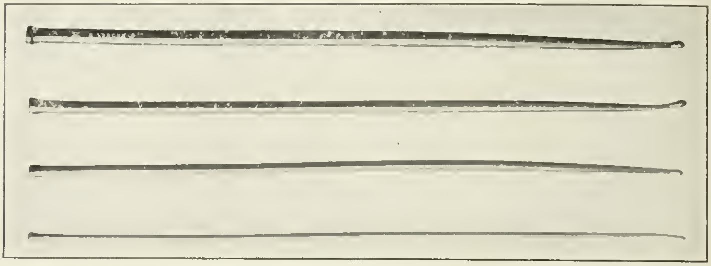


Fig. 530.—Woven Bougies.

Woven Bougies.—Woven bougies are pliable instruments made of webbing covered with a varnish which gives a smooth polished surface. (Fig. 530.) They may be softened in warm water to any degree of pliability. They are generally made with a slightly bulbous tip, much smaller than the calibre of the instrument, so that the shaft of the instrument is several sizes larger than the tip. The surface becomes easily cracked or roughened, and when this occurs the instruments are positively dangerous, as they scratch the mucous membrane. They should always be carefully inspected before they are used, and roughened instruments should be discarded. They are made in sizes which vary from the filiform up to 20 or 25 of the French scale, and are most useful in the treatment of strictures of small calibre, which may thus be dilated up to 15 or 20 F., when steel instruments will take up the work.

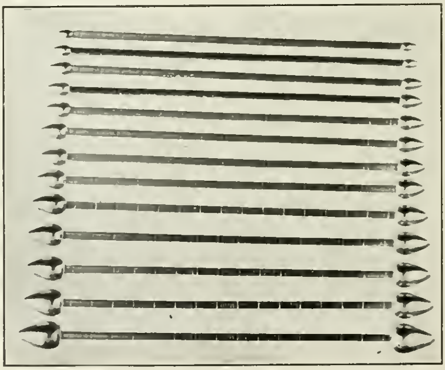


Fig. 531.—Bougie-à-Boule. This shows the form with a short, stiff shank most useful in the anterior part of the urethra.

Bulbous Bougies, or Bougies-à-boule.—These instruments have a bulbous or acorn-shaped tip attached to a small handle. (Figs. 531 and 532.) The shoulder of the instrument should meet the shaft at a sharp angle, and the ones with an oval tip are much less valuable for the detection of stricture. They are made either of webbing, as in the case of the bougies, or of steel. The webbing instruments have some advantage in that they more readily follow the course of the urethra, and in small sizes there is no danger of making false passages. On the other hand, the metal instruments wear far better and are more readily sterilized,—advantages which make them on the whole more generally useful. They are made in sizes from No. 5 to No. 30 F.

Urethrometer.—The urethrometer of Otis (Fig. 539) may be used to take the place of a whole set of bulbous bougies. It is so made that, by turning a screw in the handle, the tip is expanded into the form of a bulb, the size of which may be read on the scale in the handle. The expanded tip is covered with a rubber cap, which protects the urethra. In use the instrument is passed on as far as the membranous portion, then expanded to full size, and gently withdrawn, when it will be arrested by any obstruction which may exist in the urethra. It is distinctly more irritating than the bulbous bougie, is likely to get out of order, and has but little advantage over the simpler instruments. It belongs rather to the outfit of the specialist.

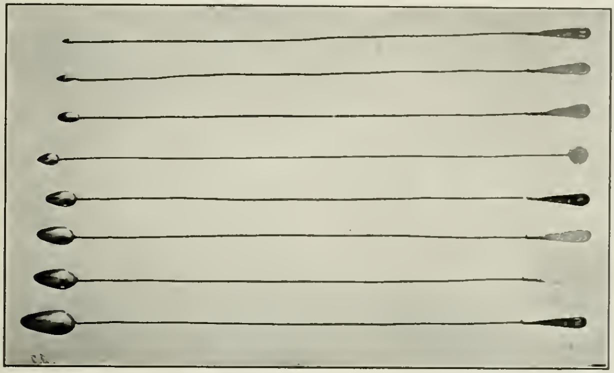


FIG. 532.—Bougies-à-Boule. These instruments have a long flexible shaft and may be used in any portion of the urethra.

Catheters.—For the treatment of strictures only two varieties of catheter are necessary—the soft-rubber and the webbing. As in every department of genito-urinary surgery the soft-rubber catheter should be used when possible, but its field of usefulness is very limited in stricture of the urethra, as it cannot be passed where any considerable obstruction exists. (Fig. 533.) It is chiefly useful in relieving retention in strictures of large calibre, and for drainage of the bladder after the stricture has been divided. The surgeon thoroughly familiar with the instrumentation of the urethra is occasionally justified in using a soft-rubber catheter on the stylet. This is a distinctly dangerous manœuvre as, should the instrument meet obstruction, the stylet is likely to perforate the tip of the catheter and damage the urethra.

Webbing Catheters.—Webbing catheters are very valuable instruments for strictures of anything but small calibre. They can be used as small as No. 10 or 12 of the French scale, and the larger sizes (up to No. 21 or 23 of the French scale), corresponding to 12 or 14 of the English scale, are also useful. (Figs. 534 and 535.) They are generally fitted with a wire stylet which may be given any desired curve, and will pass wherever a sound of corresponding size will go. After the instrument has reached the bladder, the stylet is withdrawn, leaving the catheter in place. They are subject to the same objections as are all webbing instruments, viz., that they are readily damaged and when once roughened must be discarded.

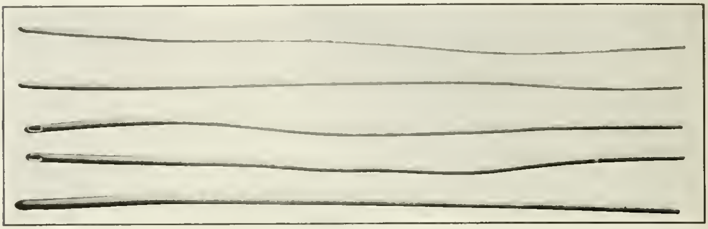


Fig. 533.—Soft-Rubber Catheters.

Sounds.—Sounds are, on the whole, the most important instruments in the treatment of stricture. (Fig. 536.) They are made both straight and curved, but for practical purposes the straight sound is rarely necessary. The end of the curved sound is made to meet the shaft with a steady curve, so that the tip is at right angles to the shaft. They are made both blunt and conical. A blunt sound has the same calibre throughout, while the tapered sound is at its

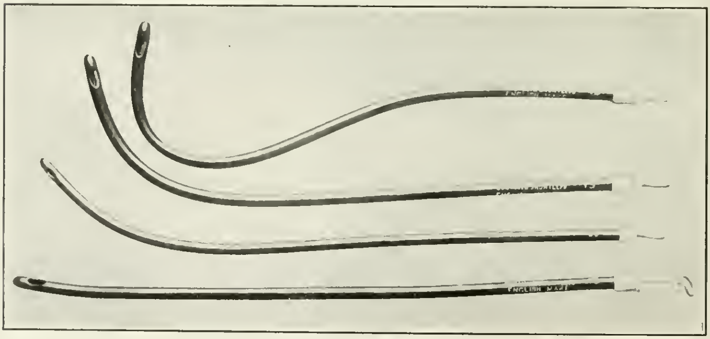


Fig. 534.—English Web Catheters with Stylet.

tip several sizes smaller than the full calibre of the instrument, which calibre is reached at about the junction of the curved portion with the shaft. The blunt sound is chiefly useful in the discovery of the stricture, while the tapered sound is more useful in its treatment. They are sometimes made with a double taper, so that the shaft tapers rapidly at a point two or three inches from its junction with the curved portion, and in this way avoids dilating the whole urethra when it is desired to stretch only one portion. This modification is distinctly useful in the larger sizes which pass the meatus with difficulty. Sounds are made in sizes from 10 to 35 F., but a complete set is by no means essential. Sizes smaller than 15 are dangerous, and should be omitted from the outfit of any but the expert. Sizes larger than No. 31 are rarely necessary. For practical purposes sounds from No. 20 to No. 30 are all that will be needed. It is essential that their surface should be absolutely smooth. The modern tendency to use nickel-plated instruments is objectionable, as the plating frequently cracks and comes off, thereby making the instrument dangerous. Polished steel or one of the alloys of copper is to be preferred.

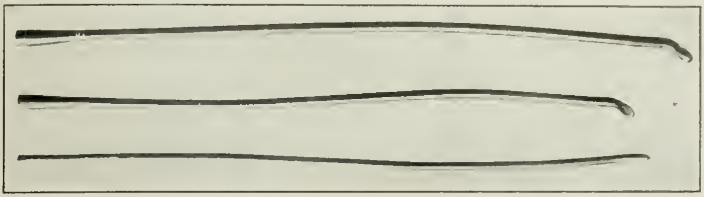


FIG. 535.—Webbing Catheters with Coudée Tip. They are used without a stylet.

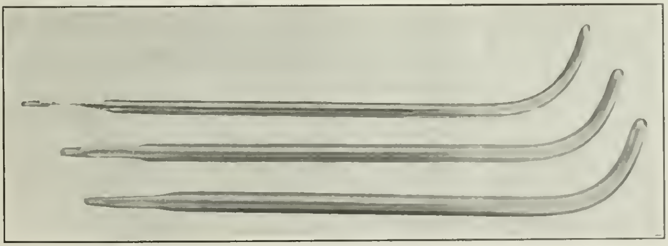


FIG. 536. Steel Sounds.

Dilators.—A great variety of dilators have been invented to take the place of solid instruments. (Figs. 537 and 538.) Of these, the one devised by Kollmann is to-day the best. It is made in three forms—straight, curved like a sound, and with the so-called Béniqué curve. A screw in the handle separates the blades which occupy the distal third of the instrument, and they can be separated up to No. 40 or No. 50 F. The instrument, with the blades closed, is about

21 F. As now constructed, the instrument does not need a rubber cover, the blades being beveled so as not to nip the mucous membrane. Some of the more complicated instruments have an attachment by which the urethra can be irrigated while the instrument is in position. Though they are very ingeniously made, I have not found them in any sense a substitute for sounds. The dilator is much less efficient, and it does not cause the same degree of absorption of the stricture. The obvious benefit of being able to use it where the meatus will not admit a full-sized instrument does not compensate for its disadvantages. I have found it most valuable in the treatment of the superficial infiltrations of the urethra in chronic urethritis.

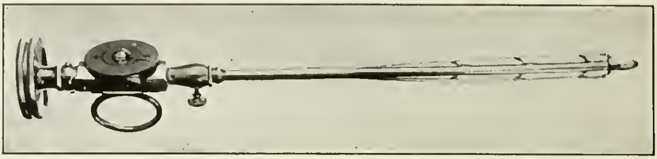


Fig. 537.—Kollmann Dilator.—The straight type of instrument is intended for use in the anterior urethra only.

Urethrotomes.—Urethrotomes are instruments planned to cut the urethra on its inner surface. For stricture at the meatus or in the first inch of the canal, a narrow-bladed knife is entirely satisfactory and no other instrument is needed. For the deeper portions of the canal two instruments are particularly valuable—the urethrotome of Maisonneuve and that of Otis. The Maisonneuve urethrotome is especially valuable for strictures of small calibre, as the instrument of Otis, as generally made, has a calibre of about 20 F. The Maisonneuve urethrotome can be used on any stricture through which a filiform bougie will pass. (Fig. 539.) It consists of a wire stylet curved at the end and provided, throughout its entire length, with a groove. In this groove runs a triangular knife which cuts on the sides but not at the apex. The instrument is made in two varieties, in one of which the knife runs upon a convexity, in the other upon a concavity. The former is intended for internal urethrotomy in the deep urethra, and is rarely useful, as this operation has to-day been largely abandoned. In the pendulous portion of the urethra all cuts should be made upon the roof, and therefore the instrument with the knife upon the concavity is to be preferred.

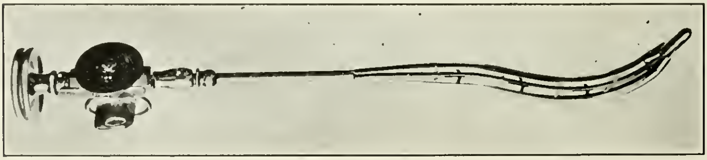


Fig. 538.—Kollmann Dilator. This instrument has the Bénique curve and may be used for any portion of the urethra.

The instrument of Otis is the instrument of election for all strictures through which it will pass. It is so constructed that its two halves may be separated like a dilator, thus rendering it possible to put the stricture on the stretch. (Fig. 540.) The knife runs in a groove on the upper surface and is concealed within the tip in such a way that traction on the handle makes the knife appear; the cutting is done from behind forward. By use of the dilating mechanism the stricture may be cut to any desired size.

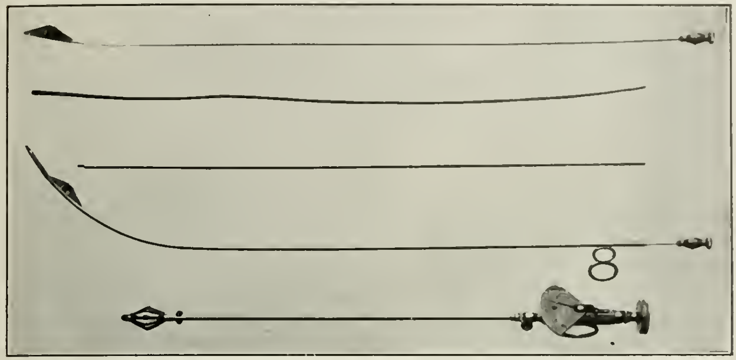


FIG. 539.—Maisonneuve Urethrotome and Otis Urethrometer. Upper picture shows the knife. Two middle pictures show filiform bougies which can be screwed on to the tip of the staff. Fourth picture shows the staff with the knife in position. Lower picture shows the Otis Urethrometer.

TREATMENT.—If we consider the question of a cure alone, the treatment of stricture of the urethra is far from satisfactory. Taken as a whole, these cases furnish only a small percentage of cures; that is, if it is understood that the term "cure" means that the patient shall remain well and that his stricture shall show no tendency to contract. On the other hand, there are few diseases which show more gratifying results if treated skilfully, patiently, and with the thorough co-operation of the patient.

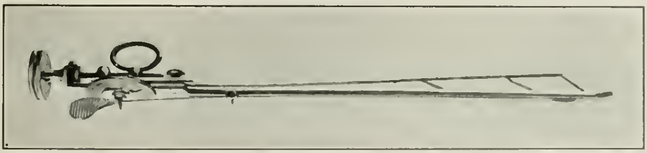


FIG. 540.—Otis Dilating Urethrotome.

Many of the poor results may be laid to two causes:—First, unwillingness of the patient to continue treatment over a term of years, and his not unnatural tendency to regard himself as well because he has no symptoms; and, second, failure on the part of the surgeon to understand fully the anatomy and physiology of the genito-urinary tract and the importance of using very great care and gentleness, which alone lead to the best results. It has been too generally believed that the management of stricture is a simple matter and can perfectly well be carried out by the busy general practitioner, or even by the patient himself. Not sufficient attention has been paid to the facts that the secondary complications are far more important than the primary lesion, and that their onset is insidious, often unaccompanied by symptoms, and frequently overlooked both by the patient and by the surgeon.

For the purposes of clearness in describing the treatment, strictures may be divided into classes or types, which, while they are at times quite distinct from each other, may overlap to almost any extent, thus rendering it possible for a stricture, at different stages in its career, to belong to several classes. We shall consider them under the following headings:—(1) Strictures of large calibre (over 20 F.); (2) strictures of small calibre; (3) strictures admitting only a filiform bougie; (4) strictures complicated with retention; (5) impassable strictures; and (6) irritable or resilient strictures.

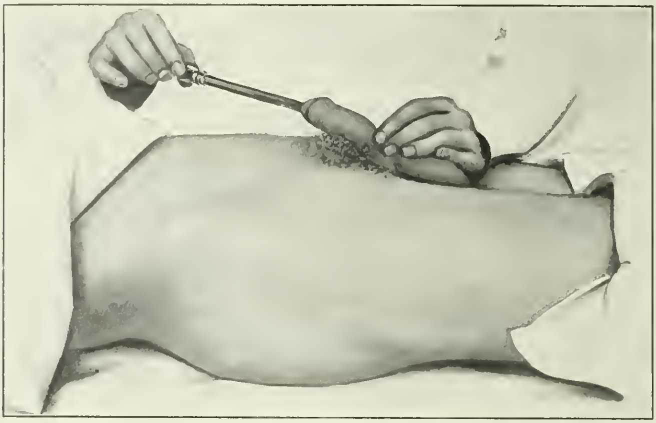


FIG. 541 The Passing of a Sound First Stage.

(1) *Strictures of Large Calibre.*—For the sake of convenience strictures of large calibre may be defined as those which will take an instrument of 20 F. The term is not used in the sense in which it was employed by the late Dr. Fessenden Otis, who frequently described strictures of over 35 F. They are strictures which may be safely dealt with by steel sounds, and their management is, as a rule, less difficult than that of any other class. Treatment should be begun only after the administration, for two or three days, of a urinary antiseptic, preferably urotropin. The calibre of the stricture is already known from the examination at which the diagnosis was made, and a sound should be selected which will certainly pass the stricture without difficulty.

As it is in this class of cases that sounds are most valuable, it will perhaps save repetition to consider here the technique of passing a sound. All sounds should be sterilized by boiling, and if they are cold, when about to be used, they should be warmed in warm sterile water and carefully lubricated with a good sterile lubricant. Sterile vaseline contained in tubes is perhaps open to as little objection as any lubricant. The non-greasy lubricants with which the market is flooded are not valuable for this purpose, as they lack the essential lubricating qualities. The most important principle to remember, in the use of sounds, is that the instrument is not only a lever of the first order, with a movable fulcrum, but is also a wedge. It is therefore wholly unjustifiable to use force. Comparatively few practitioners appreciate the amount of force which is communicated to the tip of the sound by very moderate pressure upon the handle. It may safely be asserted that, if the sound will not pass onward practically by reason of its own weight, a smaller instrument should be selected. (Figs. 541 to 545.) The instrument should be introduced in a direction corresponding to the line of the groin, generally from the patient's left, if the surgeon be right-handed. It is carried down smoothly until the tip passes the peno-scrotal angle: then the shaft of the instrument is swung steadily into the median line and the handle is slowly and evenly raised as the tip glides along the scrotal and bulbar portions of the urethra. It is in the bulb that trouble is most likely to occur, particularly through failure to follow the roof of the canal, which in this region is the fixed portion. If the beak of the instrument is allowed to follow the floor, the lax structures of the bulb allow it to fall below the opening in the triangular

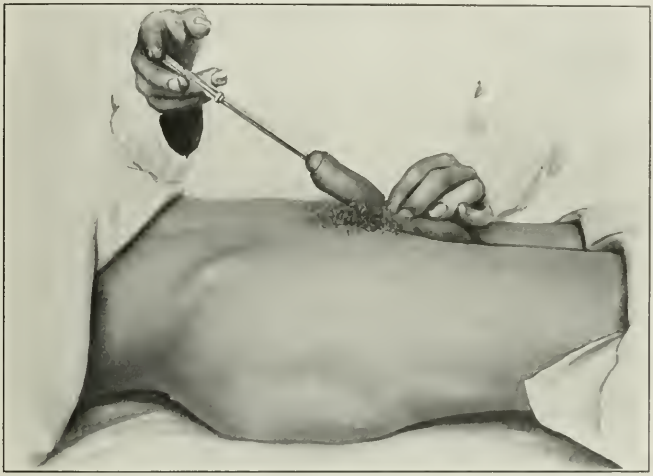


FIG. 542. The Passing of a Sound; Second Stage.

ligament, and then, as the handle of the instrument is depressed, the floor of the urethra is pushed forward below the opening. The situation resulting is shown in Fig. 546. This trouble may be avoided by keeping the tip or beak of the instrument applied to the anterior wall, and by making pressure with the fingers of the left hand on the perineum, so as to counteract the tendency of the instrument to drop backward. Where the tissues are very lax, especially in old men, difficulty here may be further avoided by putting the index finger of the left hand into the rectum while the thumb rests on the perineum. (Fig. 547.) In this way the thumb supports the sound at the junction of the curved and straight portions, thus fixing the fulcrum, while the tip of the index finger lifts the point upward to the level of the membranous urethra. This manœuvre will be found useful in manipulating any rigid or semi-rigid instrument. After the tip of the sound is engaged in the membranous urethra, the handle is allowed to fall downward between the patient's thighs, but is at the same time kept strictly in the middle line. In this way it will glide steadily forward until the handle is below the level of the symphysis, when it may be pushed gently forward in the long axis of the body into the bladder. When the instrument is in the bladder, it can be turned freely from side to side. In rare cases there will be found long false passages into which the sound will pass until it lies almost in the position just described, but it will then be found impossible to rotate the instrument and, besides, it will never lie exactly in the median line.

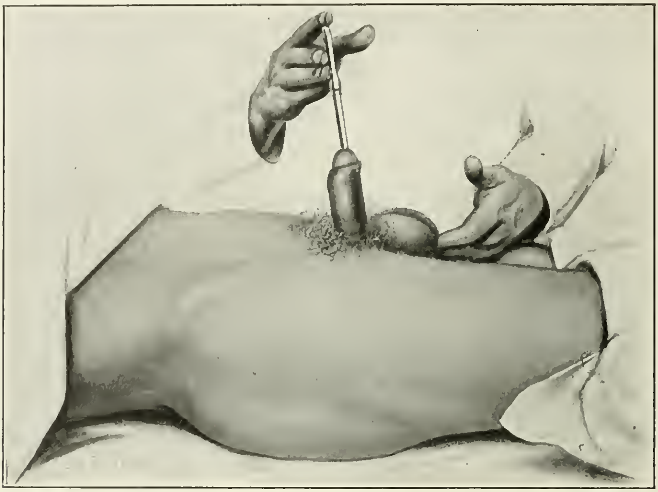


FIG. 543.—The Passing of a Sound; Third Stage.

To return to the treatment of strictures of large calibre: After the first instrument has passed through the stricture without difficulty, the next larger should be passed in succession until three or four sizes have been introduced, or until some difficulty is experienced in passing the instrument. It is a good working rule never to increase beyond the point at which the slightest tinge of blood appears at the meatus. Bleeding means tissue laceration, increased scar, possibility of infection, and, while it is not always possible to avoid bleeding altogether, avoidance of this accident is the object to be sought in all cases except when passing sounds after urethrotomy.

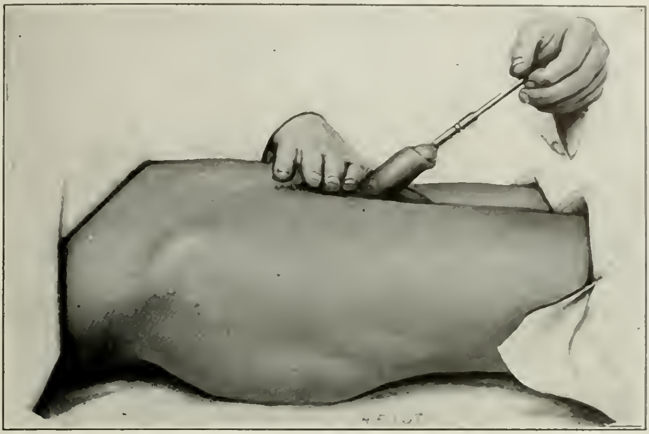


FIG. 544.—The Passing of a Sound; Fourth Stage.

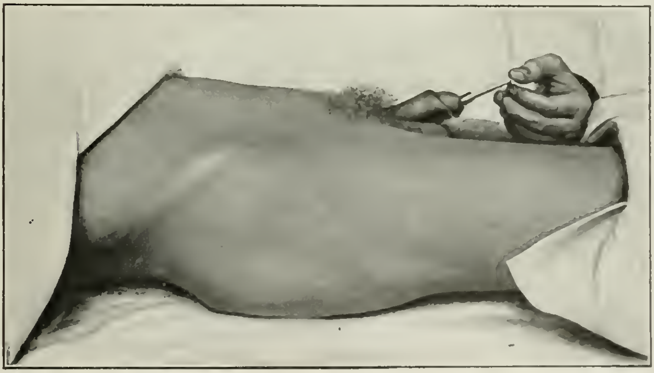


FIG. 545.—The Passing of a Sound; Final Stage.

The exact manner in which sounds produce their effects upon stricture is still a matter of discussion. The view of Guyon that the effect is produced by the mere presence of the instrument, without the aid of pressure, has been generally accepted. The effect is certainly not due to violent stretching, and apparently results from increased vascularity of the stricture, with perhaps some slight degree of inflammation,—processes which favor absorption of the scar. Too much stress cannot be laid upon the danger of employing force, or upon the importance of gentleness.

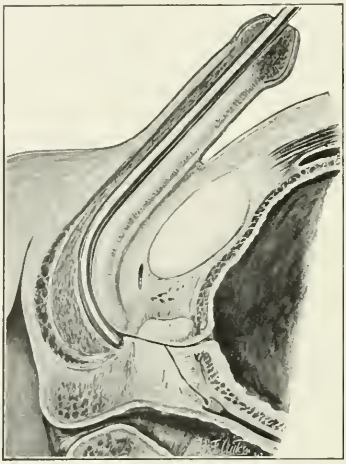


FIG. 546.—Sound Caught at the Triangular Ligament.

The frequency with which sounds should be passed depends upon the nature of the stricture. Soft strictures which dilate readily may be attacked more frequently than old fibrous narrowings, which are generally accompanied by posterior urethritis or prostatitis, and are always likely to be irritable. Strictures in the pendulous portion may be dilated more rapidly than those in the bulbo-membranous region. In general, the irritation about the stricture should be allowed to subside before further attempts at treatment are made. This will require from two or three days in the easier cases, to a week or ten days in the more difficult ones. Sharp reaction, increase of prostatitis, and especially the occurrence of fever or chills, calls for a longer interval and greater delicacy of manipulation. Instrumentation should be followed by irrigation of the urethra with a mild antiseptic solution. If instruments have been passed into the bladder, the whole urethra and bladder should be irrigated; and if this precaution were always observed, the urethral chill would become a surgical curiosity.

Considerable difference of opinion exists as to how far dilatation should be carried. The old French school regarded the use of sounds 23 to 25 as "high dilatation," while the late Dr. Otis used the same term only when the sizes of 35 to 40 had been reached. The question is not one of figures but of the peculiarities of the individual case. *Dilatation is sufficient when it overcomes the tendency of the stricture to contract.* Frequently the calibre of the meatus will obstruct the passage of instruments above No. 25. This size is rarely large enough to insure permanent results, and in many cases the meatus must be enlarged up to 31 or 32 to allow further dilatation of the stricture. To overcome this difficulty there have been devised dilators, such as those of Kollmann, which will dilate the deeper portion of the canal without the necessity of enlarging the meatus. I confess that in my hands they have signally failed to replace the sound, and, while their possibilities are attractive, they have not supplanted and will not supplant solid instruments. Though I am quite in accord with the reaction from indiscriminate cutting of the meatus, which resulted from a misinterpretation of the teachings of Otis, enlargement of the meatus to such a degree as will allow the introduction of the instruments necessary for securing full dilatation, is in the interest of the patient.

Cure by the Use of Sounds.—It is probably only in exceptional cases that a permanent cure of a stricture of the urethra is obtained by means of gradual dilatation. It is proper to employ the expression "permanent cure" only when the urethra maintains its calibre throughout a period of several years. After a calibre of 30 has been obtained, the interval between visits should be lengthened to one week, two weeks, a month, two months, and so on up to six months or a year. Patients should be advised to consult the surgeon at least once a year, to be sure that no tendency to contract exists. It is a common custom to give the patient a sound of moderate calibre and permit him to watch for himself the condition. In the case of a really intelligent patient this may be a safe procedure, but it seems to be a fact that the average patient refuses to use his intelligence in this way. It is the common experience that patients neglect their condition. They give the story that

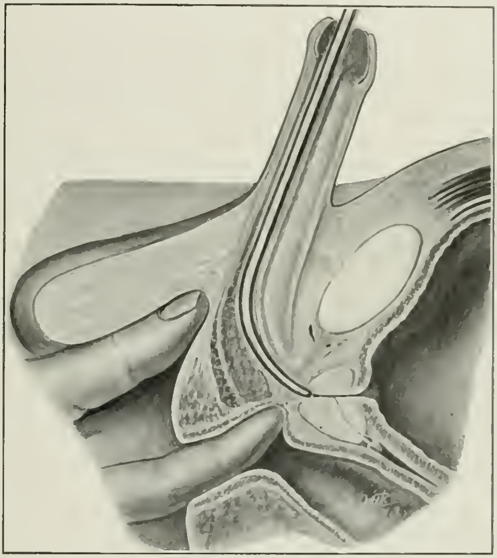


FIG. 517. A Method of Overcoming the Difficulty Shown in Fig. 546.

they abandoned the use of the instrument when they found that it was only with some difficulty that they could pass it. It never seemed to occur to them that this was a reason why they should seek further advice. I believe that trusting sounds to patients will in the long run only encourage them to neglect their condition; and besides, in the use of these instruments, they are very likely to increase the irritability or infection of the canal by failures in cleanliness and by neglect in carrying out the necessary irrigations. If the patient cannot be induced to visit the surgeon at regular intervals, the condition of his urethra will not be benefited by trusting him with the use of a dangerous instrument.

(2) *Strictures of Small Calibre.*—This group includes those cases in which the stricture is smaller than 20 F. (though larger than the so-called filiform strictures) and not complicated by retention. The administration of a urinary antiseptic is particularly important in these cases, as there is always a strong probability that secondary changes have taken place in the upper urinary tract. Dilatation should be begun with soft bougies, and for strictures of very small calibre the filiform guide with followers is particularly valuable. Great gentleness is essential, as undue irritation of the stricture may result in acute retention and may render the obstruction at least temporarily impassable. It is in these cases that irritability of the stricture, generally due to the accompanying prostatitis, is particularly likely to be encountered. Management of this complication will be considered later. A surgeon who is thoroughly familiar with the vagaries of the urethra may be justified in using steel instruments when the calibre has been increased to 15 F., but it is a safe rule for general guidance that rigid instruments should not be employed in strictures below 20 F.

If the stricture proves irritable or resilient, or if it permanently resists dilatation, urethrotomy, either internal or external, according to the location of the stricture, must be done. The frequency with which these complications are encountered will depend, in part at least, upon the willingness of the patient to obey orders and the skill with which the treatment is carried out.

(3) *Filiform Strictures.*—This group of cases includes those in which a filiform bougie can be passed, and in which no retention exists. The absence of retention enables the surgeon to avoid operative measures and to proceed in his efforts to enlarge the calibre of the urethra by dilatation. In this group of cases so-called continuous dilatation is sometimes valuable. This consists in passing the largest filiform that the stricture will admit, fastening it in position, and leaving it undisturbed during the succeeding twenty-four or even forty-eight hours. The mere presence of the foreign body will cause relaxation of the spasm and will generally allow the passage of a larger instrument at the next sitting. It is much safer to have the patient confined to bed when any form of stationary instrument is in the urethra, but this is not absolutely essential, and the method can be carried out in dispensary practice, at least when the patient is reasonably docile. Where continuous dilatation is not necessary, the small followers (Fig. 548) attached to bougies are valuable; and by one of these two methods sufficient dilatation can generally be obtained to render possible the

use of larger instruments, and thus ultimately good results may be obtained by gradual dilatation. When retention of any degree of severity occurs, or when there is undue irritability, or when the difficulty of passing a sound becomes too great, urethrotomy may have to be performed.

(4) *Strictures Complicated by Retention.*—The existence of acute retention complicating stricture demands that the surgeon promptly evacuate the bladder by one method or another, as continued retention exposes the patient to probable damage to the upper urinary tract, may inflict permanent injury upon the bladder wall, and enormously increases the likelihood of infection.

Retention by no means always means that the stricture is of small calibre. It may occur in strictures of considerable size as the result of the acute congestion following excesses or exposure to cold or wet. The first attempt to relieve the retention should be made with a fair-sized gum-elastic catheter, to which the proper curve has been given by means of a stylet. Frequently an instrument about 15 F. can be passed and the retention relieved. Should this fail, it is wise to attempt the passage of bougie-catheters, which will sometimes find their way through a stricture which is impassable to blunter instruments. If this fails, the smallest bougies should be successively tried, and then finally filiforms. If any instrument can be made to pass, it should be secured in place; the bladder will then generally empty itself alongside the instrument as the spasm relaxes.

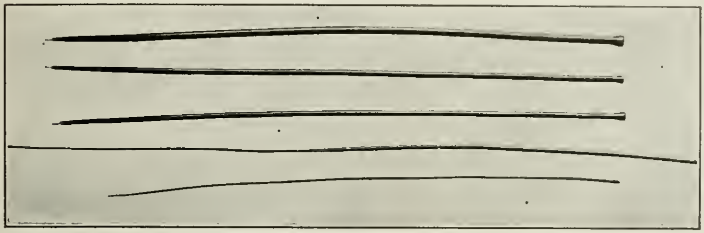


Fig. 548.—Followers which may be Attached to Filiform Bougies.

If these manœuvres fail, the patient should be placed, for fifteen minutes to half an hour, in a hot bath, the temperature of which should be maintained at a fixed point. The efficiency of this procedure is often increased by the administration of opium, preferably in the form of morphia, in doses of about one-sixth of a grain administered hypodermically. If these attempts are all unavailing, the stricture may properly be regarded as impassable and not amenable to any treatment other than aspiration or external urethrotomy.

Suprapubic puncture and evacuation of the contents of the bladder will sometimes relax the spasm, so that the urethra becomes passable in one direction or the other. It is a valuable method of treatment if instruments for more radical operation are not at hand, but, when it is employed for this purpose, arrangements should be promptly made to do external urethrotomy if the stricture fails to relax. Where all the means are at hand it is generally best to proceed at once with external urethrotomy, unless there is good reason to suppose that the obstruction is due to contraction of a stricture of large calibre, as evidenced by the fact that the patient has been having little or no trouble before the present attack. The diagnosis between retention due to stricture and that due to hypertrophy of the prostate is frequently difficult, and it is justifiable to proceed with palliative measures longer in retention due to hypertrophy than in that due to stricture.

(5) *Impassable Strictures.*—In this group it is intended to include those cases in which no instrument can be passed, although retention does not exist. As a matter of course, any stricture through which urine will pass is, properly speaking, not impassable, but the eccentricity of the opening and its relation to the anterior urethra may be such that no instrument can be engaged. The frequency with which this will occur will depend almost directly upon the skill of the surgeon. Those who are expert in such manipulations will rarely encounter any stricture through which they cannot pass some instrument, while on the other hand the novice will frequently fail. It therefore follows that, in the absence of retention or other symptoms of urgency, attempts should be made on successive occasions to pass an instrument through the stricture before one decides to perform a urethrotomy. It is in just such cases as these that skilful manipulations of the filiform bougie will often effect a passage through the stricture. The nature of these small instruments is such that they readily become caught in folds or pockets, sometimes at some distance in front of the stricture. This difficulty may be overcome by inserting several filiform bougies alongside of one another, each one being passed as far as it will go. When all the available pockets are occupied, a bougie introduced subsequently is likely to hit the opening. Each filiform instrument should be successively withdrawn a little and then pushed forward, with the hope of clearing the obstruction which it formerly encountered. Some of the instruments should be bent at the tip, so as the more readily to find eccentric openings. Their passage may at times be facilitated by injecting oil into the urethra until it fills the canal completely. It is sometimes useful to add to the oil a certain amount of boric-acid ointment—enough to give the mixture a fair degree of solidity, and yet not enough to prevent it from flowing readily through a syringe. In this way the folds in the mucous membrane are smoothed out and the opening of the stricture is more readily found.

If successive attempts, made at intervals of a day or two, fail, more radical measures will have to be adopted. The decision as to when this becomes necessary will be influenced by the occurrence of retention, by the habits and social position of the patient, and by any knowledge which may be gained of the previous history of the stricture. Patients in good circumstances, who can be kept quiet, whose diet, etc., can be readily controlled, may be watched longer than the ordinary dispensary patient, to whom time is important and whose surroundings and hygiene cannot be supervised. If there is good reason to suppose that the stricture has recently undergone still further narrowing from exposure or excess, delay is justified. Deep strictures, particularly when of traumatic origin, are likely to prove resistant and ultimately require operation, while strictures of the pendulous portion will as a rule become passable and yield to gradual dilatation. The decision may further be influenced by the opportunities which may be within reach for having the work done in the best manner. If the patient can readily be placed in the hands of a skilful operator, urethrotomy may be advised earlier than when it must be undertaken in the country or under unfavorable conditions.

(6) *Irritable or Resilient Strictures.* These forms of strictures are not grouped together because they have any necessary relation to each other, but simply as a matter of convenience. Irritable strictures are frequently not resilient; and most resilient strictures are not irritable.

Irritable strictures are those in which, in spite of care and the administration of a urinary antiseptic, chills or other evidence of inflammation regularly follow instrumentation. There is, as a rule, evidence of prostatitis or inflammation of the upper urinary tract,—conditions which in themselves call for relief of the obstruction. That chills of a purely nervous origin may occur is not denied, but in the vast majority of cases they are of bacterial and not nervous origin. True irritable stricture requires urethrotomy. If due care and skill have been employed and irritability still persists, the indication for operation becomes clear. Conversely, if the irritability is due to mismanagement, no operation is indicated.

A resilient stricture is one which, though persistently dilated, fails to retain its calibre. Such strictures are most commonly seen in the bulbo-membranous portion, and are frequently traumatic. When the tendency to recontract has once been clearly demonstrated, operation should be done. If the apparent resiliency is due to failure to dilate the urethra sufficiently, or to failure on the part of the patient to follow up treatment, dilatation should be persisted in, as operation is no guarantee of more skilful methods or of improved habits on the part of the patient. It is in these resilient strictures that the most radical forms of operation—partial or complete resection, or fistulization—may be indicated.

Operations for Stricture.

Internal Urethrotomy.—Internal urethrotomy is the operation of election for those strictures in front of the bulbo-membranous portion which cannot be managed by dilatation. It has frequently been applied to strictures of the deeper portion of the canal, but the dangers of hemorrhage and sepsis make it a more serious operation than external urethrotomy. Harrison proposed doing an internal urethrotomy in combination with external incision for drainage. This has no real advantage over external urethrotomy and has never been extensively adopted.

Internal urethrotomy is indicated in the following conditions of the anterior urethra:—(1) Strictures or congenital narrowings of the meatus; (2) resilient or irritable strictures; (3) resistant strictures; (4) strictures which are complicated by abscess, infiltration, or fistula, and which demand perineal section—the stricture of the anterior urethra being cut at the same time; (5) strictures of moderate calibre, in which the operation is performed in order to gain room for the introduction of large instruments, as for litholapaxy; and (6) strictures in which it is desirable, for one reason or another, to shorten the time of the treatment.

Technique of the Operation.—Urinary antiseptics, efficient care of the bowels, and a light breakfast, if a general anæsthetic is to be used, are matters of routine. The operation may be done under either local or general anæsthesia. Quite efficient local anæsthesia may be obtained by injecting a four-per-cent solution of cocaine into the urethra and allowing it to remain for ten minutes. The objection to local anæsthesia is that it is by no means always satisfactory, the rapidity and completeness with which the cocaine is absorbed depending upon the condition of the urethra. Furthermore, it is difficult to limit the action of the drug, and toxic symptoms occasionally follow. Unless some real objection exists, a general anæsthetic is more satisfactory.

After the anæsthesia is complete, the anterior urethra should be irrigated thoroughly. All incisions should be made on the roof. For strictures of a calibre less than 20 F. the Maisonneuve or Civiale urethrotome should be used. With the Maisonneuve the guide is inserted so that its tip is in the bulbous or membranous portion of the urethra. The knife is then fitted to the groove and pushed forward, being kept accurately in the middle line on the roof until the stricture has been divided from before backward. The Civiale instrument must be passed through the stricture, which is then cut from behind forward. It cannot be used on strictures as narrow as those amenable to the Maisonneuve instrument.

After the cut has been made, sounds should be passed to ascertain that the calibre of the urethra has been restored. If this is not the case and further cutting is necessary, the work may be finished with the Otis urethrotome. This is passed into the urethra until the part containing the knife lies behind the posterior face of the stricture. The blades of the instrument are then separated until the stricture is put upon the stretch, when the knife is withdrawn so as completely to divide the stricture, the length of which has been previously ascertained. The knife is then returned to the sheath, the blades brought together, and the instrument withdrawn.

After internal urethrotomy the urethra should admit at least a No. 30 F. sound, the meatus being divided to accommodate this, if necessary. The operation is completed by irrigating the urethra and putting in a stationary catheter, or not, according to the judgment of the surgeon. This point must be decided by the nature of the stricture and the extent of the infection in the deep urethra or the upper urinary tract. Where the stricture is tight and of long standing, it is safer to put in a stationary catheter for from twenty-four to forty-eight hours. In most irritable strictures and in strictures which are associated with serious damage to the upper urinary tract, the stationary catheter is a guarantee of safety from infection. The only objection to its use is that it always causes a temporary urethritis, which, however, is not serious if the catheter is not left long in position. For strictures of large calibre a stationary catheter is not necessary.

After-Treatment.—The after-treatment consists in the passing of sounds at short intervals through the stricture, but it is not necessary or desirable that they should be passed into the bladder. The passing of a full-sized sound every other day, followed by irrigation of the urethra during a period of two weeks, is generally sufficient. Frequent passing of sounds should be continued until no bleeding follows instrumentation, this result showing that healing is complete. After this the case should be treated like any stricture in which full dilatation has been obtained.

Complications.—The only two complications of importance are hemorrhage and sepsis. In rare cases the operation is followed by sharp bleeding, which may be generally controlled by simple pressure or by bandaging the penis. If this fails, a full-sized catheter should be introduced, when pressure with a bandage will check the hemorrhage.

Sepsis may occur in two forms. The general, severe type due to rapid absorption through the wound may be ushered in by chills and severe constitutional disturbances. Its treatment is that of general infection elsewhere; but its occurrence should be a very rare event where proper precautions have been observed in regard to urinary antiseptics and irrigations. Once in a while infection may take place at the point of incision and give rise to local periurethral abscess, which should be treated as any other abscess is.

Mortality.—From large statistics it would appear that the mortality of these operations is one and one-half per cent. It is hard to believe that under modern conditions the risk is anywhere near as great, and it will be disappointing if cases collected during the present century show a death rate of over one-half of one per cent.

Results.—Statistics carefully collected by Watson show that a cure results in from fifty to sixty per cent of the cases operated upon. This result, however, is obtained only in properly selected and efficiently treated cases.

External Urethrotomy: Perineal Section.—For practical purposes the terms external urethrotomy and perineal section are synonymous when applied to a stricture of the urethra; for external urethrotomy is practically never done for this purpose except on a perineal portion of the urethra. Perineal section is the operation of election for those strictures of the bulbo-membranous portion of the urethra which require cutting. It is indicated in the following conditions: —(1) For strictures complicated by extravasation of urine, abscess, and urinary fistula; (2) for resilient or irritable stricture of the bulbo-membranous portion; (3) for impassable stricture; and (4) for rupture of the urethra.

The operation of perineal section may be one of the easiest or one of the most difficult in surgery. In ordinary cases in which a guide can be passed the operation may be completed in a few minutes. On the other hand, perineal section without a guide may require patience and skill of a very high order, and in rare cases it may be impossible to find the deep opening of the urethra in the perineum. It should never be undertaken without good assistants, a proper assortment of instruments, and all facilities for doing a major operation. It is not an operation which the occasional surgeon can do to advantage, and familiarity with the region greatly diminishes the probability of meeting serious obstacles. The preparation is that for any major operation. Since in many instances the general condition of the patient is poor, the kidneys damaged, and infection present, every effort should be made—where time permits—to get the excretory organs, particularly the skin and bowels, in first-class condition.

Technique of the Operation.—As a rule, the operation should be done under full general anæsthesia. If the risk of a general anæsthetic is very great, it is possible to do the operation with the aid of local anæsthesia, especially if a guide can be passed. The refinements of technique can hardly be carried out under local anæsthesia, and only simple drainage will be effected.

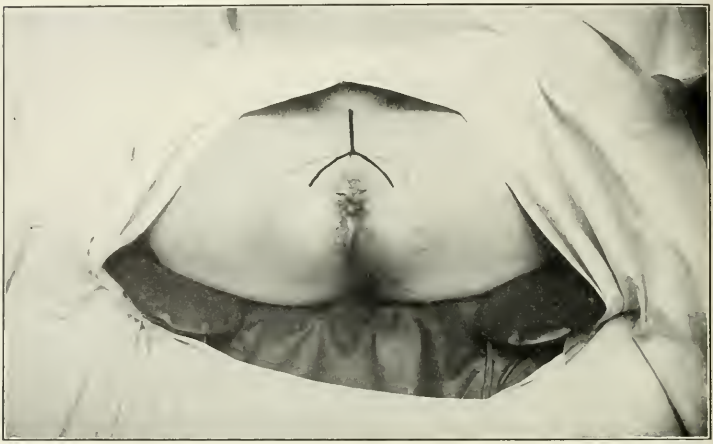


Fig. 549.—Patient in Position for Perineal Section. Skin incisions, straight and curved, are marked in black.

The patient should be placed in an exaggerated lithotomy position, with the pelvis raised and the thighs strongly flexed upon the abdomen, so as to bring the perineum into a nearly horizontal position. This position may be maintained by the use of a crutch with a strap passed around the patient's neck, or by fastening the knees with a folded sheet,—a somewhat less satisfactory method. The leg holders which are commonly used in gynæcological operations, entirely fail to give the correct position and greatly add to the difficulty of the operation. Their use has been a not infrequent cause of difficulty in finding the urethra.

Perineal Section with a Guide.—Considerable effort should be made to pass a guide through the stricture, as this at once converts the operation from one of considerable difficulty to one of perfect ease. The guide, when passed, should be held strictly in the middle line by an assistant, who also holds the scrotum up out of the way. The incision, which should be made exactly in the middle line, begins at about the posterior border of the scrotum and extends backward to a point one inch in front of the anus. (Fig. 549.) The dissection is then prosecuted, the work being kept rigidly to the middle line until the urethra is reached, when the scar tissue about the stricture can, as a rule, be felt. If the exact location of the stricture is doubtful, the urethra is opened in the bulb in front of the stricture, and a narrow-bladed knife is then carried backward so as to divide the stricture on the floor. When the stricture has been fully divided, the deep urethra should be dilated by passing either a full-sized sound or the index-finger into the bladder. The operation is completed by establishing drainage, which may be done by placing either a perineal tube or a catheter in the urethra. (Fig. 550.)

When the general condition is not a serious one, catheter drainage has the advantage of allowing the wound to be partially closed by suture and will often result in healing practically by first intention. In the presence of chronic cystitis or infection of the upper urinary tract, drainage with a perineal tube brought out through the wound is probably more efficient. If a tube is used it may be removed in three or four days and the bladder allowed to drain through the wound. A catheter, on the other hand, should be left in place, or, if removed, it should be replaced until the wound is practically healed. The urethritis which habitually accompanies the use of the catheter has not seemed to me to complicate wound healing or to affect the ultimate result unfavorably.

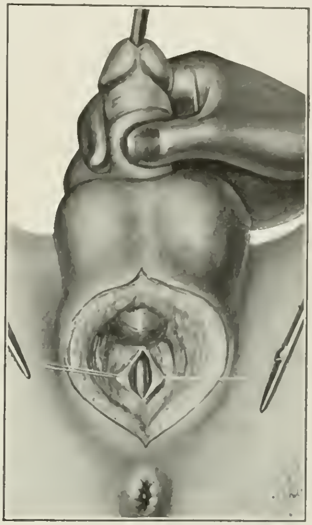


Fig. 550.—Perineal Section. This shows the guide sutures in place, the stricture divided, and the bladder drained with a catheter. N.B. The bulb is here shown too far forward.

Perineal Section without a Guide.—If no instrument can be made to pass the stricture the operation must be done without a guide. It is here doubly important that the position of the patient, with the parts occupying exactly symmetrical positions, should be rigidly maintained.

A curved or straight staff should be passed down to the anterior face of the stricture and a median perineal incision should be made opening the urethra on the end of the staff. The edges of the wound in the urethra are then caught with "stay" sutures and held open so as to expose the face of the stricture. Search is then made for the opening with a small silver probe or director, and if a dry wound has been maintained, if the dissection has been kept strictly in the middle line, and if care has been taken not to divide the roof of the urethra, it is generally possible to find the opening. If the bladder contains considerable urine, as is often the case, suprapubic pressure will often force a few drops out through the stricture, and thus disclose the opening. If, after a moderate amount of time has been spent in hunting for the opening in this way, it cannot be found, it is best to expose the membranous urethra by a curved incision which passes from one tuberosity of the ischium to the other, and crosses the lower end of the vertical incision. The rectum is pushed backward after the perineal muscles have been divided, just as is done in some operations on the prostate. This will expose the apex of the prostate and the membranous urethra behind the stricture, for the whole membranous urethra is practically never involved. In this way the urethra may be opened at two points,—one in front of and one behind the stricture,—and it is then possible to find the opening. Or it may be sufficient simply to divide the intervening tissue which consists chiefly of new-formed scar tissue. If the stricture is known beforehand to be long and tortuous, it is often best to adopt this plan from the start, and, after exposing the region of the stricture, to open the urethra behind it and attack the enemy from the rear. In rare cases, when the posterior opening cannot be found, it may be necessary to open the bladder above the pubes and to do retrograde catheterization. This is always an admission of weakness in technique and should rarely be necessary if the surgeon is thoroughly familiar with the anatomy of the region. A communication through the stricture having been established, the operation may be concluded as in perineal section with a guide; or resection or fistulization may be done.

Resection of the Stricture.—In traumatic strictures with much scar formation, and in old fibrous inflammatory strictures complicated by fistula, resection of the diseased portion may be done to advantage. The steps of the operation are similar to those just described under Perineal Section Without a Guide. After the stricture has been divided, the urethra is cut across cleanly, above and below, in healthy tissue. The anterior segment of the urethra should then be freed from the surrounding tissues and mobilized to any extent necessary to permit it to be joined to the posterior segment without tension. The suturing is then done preferably with interrupted catgut passed from without inward and including the mucous membrane. Suturing is begun upon the roof and, after about one-quarter of the work is completed, a full-sized soft-rubber catheter should be passed from the meatus to the bladder, and the suturing should be completed about this as a splint. The wound may be practically closed and no wound drainage is necessary.

Partial resection may be done when the scar involves only a portion of the urethra, or portions of the scar may be cut away so as to reduce the total amount.

Fistulization.—This is an operation recently advocated by French surgeons and is applicable to the worst cases with extensive sinus formation or tissue destruction. It consists in making a more or less permanent fistula in the perineum by suturing what remains of the urethral mucous membrane to the skin. The advantage to be gained is the absorption of the excess of scar, which is accomplished by relieving the tissue of irritation and infiltration. After an interval of several months or a year or more, the tissues become soft and pliable and the fistula may then be closed by turning in flaps. The objection to the operation is that it leaves the patient for a long time with a perineal meatus, and he is likely to be lost sight of before the time comes for completing the operation. It is, however, an operation of undoubted value in bad cases.

Results.—The mortality of perineal section has been recently reported by Watson as nine per cent. This high death rate is due to the bad condition of the patients on account of neglect, and does not, strictly speaking, represent the risk of operation. The operative dangers are quite trivial. A cure—that is to say, permanent freedom from the tendency to contract—is not common. On the other hand, patients who follow up treatment conscientiously will, in the majority of cases, need to visit the surgeon only two or three times a year.

Suprapubic Aspiration of the Bladder.

Suprapubic aspiration or puncture may be indicated in the following conditions:—(1) Acute retention with impassable stricture, in which previous knowledge of the case makes it seem probable that the stricture will relax and become passable; (2) when means are not at hand to do perineal section.

Technique of the Operation.—No anæsthetic is necessary, though it is wise to anæsthetize the skin at the site of puncture with cocaine. The skin above the pubes should be prepared as for a surgical operation. The instruments required are a small needle at least four inches long, such as is commonly used for tapping the chest, and an aspirator. Any type of aspirator which will do effectively the work demanded of it, will serve the purpose. Just before the puncture is made, the suprapubic region should be carefully percussed to make sure that the bladder is distended and that a coil of intestine does not lie in front of it. The needle should be inserted in the median line one-half inch above the pubes and pushed directly backward at right angles to the abdominal wall. If it is carried downward it may go in front of the bladder and enter the prostate. As a rule the urine will flow freely through the rubber tube attached to the needle, and the aspirator need not be used. When the bladder is empty the tubing should be detached and the needle rapidly withdrawn, the finger being kept firmly pressed over the end. This will prevent the escape of a few drops of urine in the track of the needle. Keyes advises aspirating during the withdrawal of the needle, especially in cases where the bladder is infected This seems more likely to draw infected urine into the needle-track than to prevent the danger.

If the bladder is filled with pus and mucus, aspiration may be necessary. If an excessive amount of mucus or blood-clots is present it may be impossible to evacuate the bladder in this way. It is probably better to do suprapubic cystotomy, if necessary under cocaine, than to attempt to evacuate the bladder with a large trocar, as infiltration of urine is likely to occur.

The bladder may be repeatedly aspirated without untoward results, and it is far better to make several punctures than to leave the needle in place as has been suggested, as infection along the needle-track is almost certain to occur.

VI. COMPLICATIONS OF STRICTURE OF THE URETHRA.

Strictly speaking, all secondary changes in the urinary tract resulting from neglect or mismanagement should be classified as complications. Many of these, such as infection, hypertrophy and dilatation of the upper urinary tract with the resulting pyelitis and pyelonephritis, etc., are in no way peculiar to stricture and need not be considered here. Only those changes which are more important and which are peculiarly the result of urethral infection and obstruction need be taken up.

False Passages.—A false passage is the contribution levied by stricture upon the patients of the ignorant, careless, or inexpert. It is always the result of the use of undue force in passing instruments, but this force may be by no means great, and it often seems quite insufficient to do damage. These passages may be long or short, large or small, and they may be situated in any part of the anterior urethra, but the orifice is always in front of the stricture. They are produced by instruments which leave the canal near the anterior face of the stricture, having become caught in a pouch or pocket or at the triangular ligament. In their worst forms these false passages result from that barbarous procedure known as forced catheterization, by which, in patients affected with retention of urine, a catheter is forced through the obstruction in the line where it is thought that the urethra ought to lie. Such a procedure has no justification in surgery and is mentioned only to be condemned.

The production of a false passage is an occurrence which is generally known at the time, for, when a stiff instrument is used, it will be found to lie somewhat out of the proper axis of the canal, and its withdrawal will be followed by bleeding. This bleeding not infrequently lasts for many hours or even days, but, in the great majority of cases, if the cause of the trouble is recognized and the condition is properly handled, no serious results follow.

Of quite as much importance is the recognition of old false passages, the result of the efforts of some previous attendant. If the surgeon is on his guard their recognition is not difficult, as the instrument will bring up in front of the stricture and will be found to lie somewhat, even though slightly, out of the proper axis of the canal. These false passages are, as a rule, lined with epithelium, and if they are dealt with gently no bleeding will occur. The prompt recognition of the existence of such a passage, and of the exact position which it occupies, is essential to the successful treatment of the lesion. To prevent the engagement of an instrument in one of these blind pockets it is necessary to make its tip hug the opposite wall at this point. Not very infrequently more than one will be found, so that the successful passing of an instrument through the stricture is effected only by dodging these traps. Their presence and relations should be carefully recorded so that their exact location and peculiarities may be remembered.

Treatment and Management.—The essential treatment of a newly created false passage is to leave the urethra strictly alone until healing has largely taken place. This generally means that for a week, or even for two weeks, no instrumentation of the urethra should be undertaken beyond irrigation of the anterior canal; and dependence should be placed upon a hygienic régime and medicinal treatment to keep the urethra in good condition and thereby to promote healing. At the end of this time dilatation of the stricture should be cautiously begun, and when once the proper opening is found and the stricture dilated, these acute false passages frequently heal and give no further trouble. On the other hand, failure to recognize their presence or unwise instrumentation frequently results in their becoming permanent and an obstacle to the success of future efforts at dilatation.

In the chronic lesions, where the passage has become lined with epithelium, no treatment short of operation will cure. On the other hand, these false passages rarely produce trouble except when aroused by insult, and all that is necessary is to recognize their presence and to leave them alone. Occasionally an acutely formed false passage or a chronic one which has been roughly handled may give rise to periurethral abscess, the treatment of which differs in no respect from that required in periurethral abscesses of a different origin.

Complications due to Neglect.—The most striking complication, which is more or less directly due to neglect of a stricture, is that inflammatory condition in the neighborhood which is spoken of as "infiltration of urine." The formerly accepted doctrine that "infiltration of urine" is the result of rupture of the urethra from inflammatory infiltration behind the stricture must, in the light of the recent work by Escat, Hallé, and Wassermann, be discarded, as there is a striking lack of evidence to show that spontaneous rupture of the urethra behind a stricture ever occurs. This and other forms of perineal suppuration are a direct consequence of the chronic urethritis which almost universally exists behind the stricture. Thus, from the same fundamental cause arise the small periurethral infiltrations, periurethral abscesses and fistulæ, and the more massive malignant infections included under the term "infiltration of urine." It should be clearly understood that these processes bear little or no relation to the calibre of the stricture, but are dependent upon the occurrence of local inflammation and are mild or severe, circumscribed or diffuse, according to the nature of the infecting organism, the local resistance of the tissue, and the general condition of the patient. Severe, extensive, and even fatal infiltrations of urine may occur behind strictures of large calibre, and, on the other hand, a narrow or even an impassable stricture may exist for months or years without giving rise to any such accident. These processes habitually arise as a glandular or periglandular inflammation. As a rule, they start in the tissues surrounding the glands of Littré in the bulb, less commonly as an infection of Cowper's glands. In many cases they doubtless exist and run their course without causing symptoms sufficient to attract attention, and it is only when they break through into the periurethral connective tissue that they assume clinical importance. For convenience of description they may be divided into three main groups:—Periurethritis, periurethral abscess, and urinary infiltration. It should be borne in mind, however, that the pathogenesis of the cases belonging to these groups is essentially the same and that they differ in degree rather than in kind.

Periurethritis.—Periurethritis is an almost habitual complication of strictures of long standing. Its presence manifests itself in the form of a nodular thickening in the region of the stricture, and in many cases there may be felt distinctly separate, pea-sized lumps, which represent small periurethral or follicular abscesses. From this condition arises the next type, namely, periurethral abscess.

Periurethral Abscess.—Periurethral abscess, as already stated, differs in no essential particular from the periurethral abscess which develops in the course of a gonorrhœa (see page 752), excepting that it is more likely to be found in the perineum, chiefly because this is the most common seat of stricture. In typical cases there appears rather suddenly, in the region of the bulb, a red, hot, and tender mass which is generally accompanied by fever and other constitutional symptoms and occasionally by chills. If left to itself the abscess may drain into the urethra and the inflammation subside; it may rupture externally and give rise to a more or less persistent sinus; or, finally, it may drain in both directions, giving rise to a urinary fistula or even, in a certain number of cases, to multiple perineal fistulæ, one or more of which communicate with the urethra—a condition which is commonly spoken of as "watering-pot perineum." (Fig. 551.) If a considerable proportion of the urine is passed in this way, the tendency of the stricture to contract may become more marked, thereby favoring the continuance of the fistulæ and assuring their permanency until relieved by operation. In badly neglected cases these fistulæ may become numerous and complicated, burrowing through the subcutaneous tissues for some distance and ultimately reaching the surface on the thigh, groin, and various parts of the scrotum or lower abdomen.

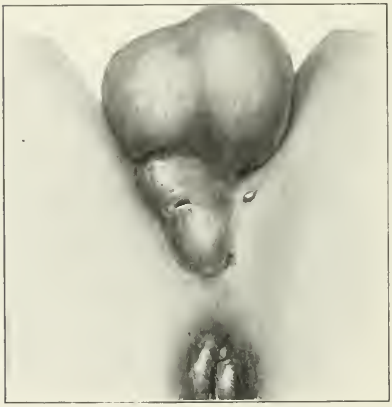


FIG. 551.—Periurethral Abscess with Multiple Fistulæ. The illustration shows a case of chronic periurethral abscess with three fistulæ the result of former acute exacerbations similar to the one which has produced the present abscess.

Urinary Infiltration.—This term, as a matter of fact, is a misnomer, for the infiltration of urine is a purely secondary accident, the essential process being a diffuse inflammation which starts in the bulbar portion of the urethra, spreads rapidly, and is limited only by the anatomical arrangement of the fasciæ. The part played by the urine in this process is entirely secondary, and, in at least a certain proportion of the cases, it plays no part at all. There is some reason to suppose that this process is due to a specific anaërobic bacillus. It begins as a tender, œdematous swelling in the region of the bulb and progresses rapidly, being limited, by the arrangement of the fasciæ, to the perineum, the scrotum, and the anterior abdominal wall. The process never finds its way down the thighs nor below the groin, but reaches the abdominal wall through a gap in the fascia in the region of the spine of the pubes. It may spread upward, following by preference the line of the groin, until it reaches the lateral or even the lumbar regions. The loose tissues of the scrotum are particularly susceptible, and enormous swelling, with gangrene, not infrequently occurs. (Fig. 552.) In advanced cases there is even extensive sloughing of the perineal portion of the urethra, and large pockets containing urine may form in this region, but, strange as it may appear, the bladder is never involved in the gangrenous process, though a large portion of the urethra may slough. The process is accompanied by all the signs of an acute septic infection—high temperature, weak and rapid pulse, chills, nausea, and vomiting. The infection is an extraordinarily malignant one and death may occur within forty-eight hours. To describe all the varieties which occur,—depending as they do upon the virulence of the process, the local resistance or lack of resistance, and the general condition of the patient,—would require more space than we can devote to it. The following striking observation, however, may give one some idea of a type of this complication which is occasionally encountered:—

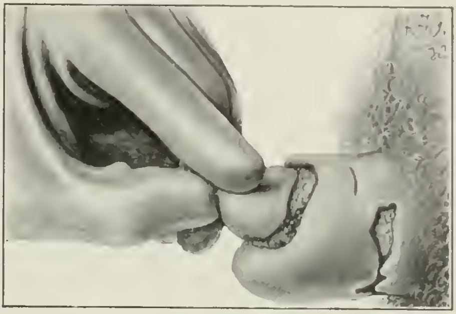


FIG. 552.—**Results of Infiltration of Urine.** The illustration shows the results of extensive subcutaneous gangrene which involved the skin of the penis as well as the scrotum and has left multiple sinuses and areas of necrosis.

A man of 40, known for many years to have had a stricture of rather large calibre, was seen by his physician at 3 P.M., Saturday afternoon. A No. 28 sound passed without difficulty into the bladder. That evening he complained of soreness in the perineum and the next morning he was found to have a temperature of 103° F.; there was much swelling of the perineum and scrotum and the pulse was weak and rapid. When he was seen at about 3 P.M. on Sunday, the scrotum was enormously swollen and bluish-black in color, while the lateral portions of the abdomen, as far as the anterior superior spines of the ilium, showed a brownish, dusky appearance and were extremely tender. Urine was passed freely without apparent obstruction. Temperature was 105° F. Pulse was too rapid to count and at times was imperceptible. No operation was done, and the patient died at 6 P.M., twenty-seven hours after the earliest time at which the process could have begun.

TREATMENT.—The treatment of chronic periurethritis and its not infrequent exacerbations is the treatment of the stricture. The process is dependent upon the chronic urethritis, and this in turn is dependent upon the stricture. A cure cannot be obtained in the presence of urethral obstruction. On the other hand, it is scarcely possible to return the parts to a normal condition even after the stricture has been efficiently dilated. Hence, a more or less chronic urethritis, which waxes and wanes with the condition of the stricture itself, is apt to be a permanent tribute levied upon the urethra.

Treatment of Periurethral Abscess.—To be effective the treatment of periurethral abscess must include the care of the abscess itself and the care of the stricture with which it is often associated. The latter need not be considered here. The treatment of the abscess is incision and drainage. There has, in the past, been some tendency to temporize with these lesions, but such a temporizing policy has nothing to recommend it. The mere fact that these abscesses can be quieted to such a degree that for months they do not cause serious inconvenience, is not to be regarded as evidence that this treatment is efficient. Such treatment only leads to the formation of an increased amount of scar tissue, to more permanent periurethral damage, and therefore to a corresponding degree it makes the ultimate condition more difficult to deal with. With the exception of the most minute lesions, which simply represent highly inflamed follicles, periurethral abscess in connection with stricture should be freely incised and drained as soon as the diagnosis is made. It is to be remembered that the pus often works its way to the surface by a rather devious route, and it is therefore of importance that the abscess should be reached in its entirety and not simply the superficial portion drained. Simple opening of the superficial abscess is not infrequently followed by a persistent sinus, which means that the deeper part of the lesion has not been reached, and this fistula may in time communicate with the urethra and become a urinary fistula.

Technique of the Operation.—Preparation should be made as for a major operation. It is never wise to undertake the cure of these lesions with insufficient preparation. A general anæsthetic is practically always required, as considerable dissection of the perineum may, in the course of the operation, be found necessary. The patient should be placed in an extreme lithotomy position; an instrument should be passed into the urethra in such a manner that its relation to the abscess may at all times be clear; and, finally, an incision should be made over the prominence of the swelling. With a good light and a dry field, the dissection should be prosecuted until all parts of the abscess have been efficiently opened. While carrying out this dissection one must be careful scrupulously to avoid injuring the urethra; and yet at the same time one must remember that the origin of the process is generally in the immediate vicinity of that structure, although there is frequently no communication between the two. When all pockets and side tracks have been opened, the wound may be curetted, any excess of scar tissue excised, and the wound finally packed with gauze. The after-treatment should consist in keeping the wound from closing too rapidly, lest a persistent sinus form. In the more severe cases, in which a communication with the urethra can be demonstrated, it is often wise to open the urethra behind the fistula and drain the bladder with a tube, thus insuring more peaceful healing of the inflammatory process.

Treatment of Urinary Infiltration.—As this is the most malignant of inflammatory processes, treatment should be prompt and energetic. No lesion in surgery shows more brilliantly the results of a bold and efficient incision, while, on the other hand, delay is in no other condition fraught with greater danger. Operation should be done at the earliest possible moment. It has a dual object: first, the drainage of the bladder, and, second, the laying open, by incision, of all the inflamed or infiltrated parts. A very free incision should be made, and one need have little fear of doing more than the condition requires. As these patients are frequently in poor condition, as much speed as is compatible with thoroughness should be employed.

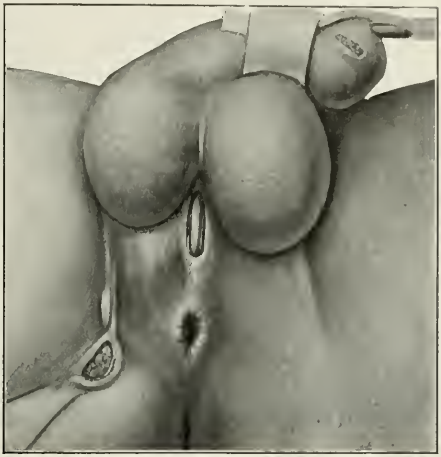


FIG. 553. Results of Infiltration of Urine. Another view of the case which is shown in Fig. 552. The scars on the left show the extent of the perineal process. The exposed portion of the catheter in the perineal wound shows the extensive destruction of the urethra. This patient will probably always have a perineal meatus.

Technique of the Operation.—A general anæsthetic is always necessary. If an instrument can be made to pass the stricture it should be used as a guide for a median perineal section. The deep urethra should be dilated and drainage of the bladder secured. Then all pockets, such as are most likely to be found in the region of the scrotum, should be freely incised; no special attention being paid to the anatomical structures divided by the knife. If the process has extended in an upward direction, reaching the abdominal wall, incisions starting from the perineal wound should be carried freely upward, on one or both sides, to the extreme limits of the process. Where the subcutaneous tissue is extensively infiltrated, the removal of masses of necrotic fat will frequently hasten convalescence. In any case the dissection should be carried in all directions into healthy tissue.

It is generally wise to flush the wound thoroughly with a strong antiseptic solution, the most active being a carbolic-acid solution and Harrington's Solution. It should then be packed widely open with gauze, the bladder drained with a perineal tube, and a large absorbent dressing applied.

The effect of such an operation is frequently almost miraculous, and, even when the lesions are very extensive, satisfactory results are generally obtained. Where, as not infrequently occurs, excessive portions of the bulbous urethra have been destroyed, healing may be accompanied by the formation of a serious stricture, or, in the worst cases, the loss of substance may be so great as to require the formation of a permanent perineal fistula. (Fig. 553.) In the long run the after-treatment may include most of the problems of the worst type of stricture of the bulbous urethra.

SURGICAL DISEASES AND WOUNDS OF THE JAWS.

By JOSEPH C. BLOODGOOD, M.D., Baltimore, Maryland.

In this article there will be considered the anomalies, injuries, inflammations, and tumors of the upper and lower laws, their medullary cavities, and the surrounding soft parts.

The lesions which surgeons are called upon most frequently to diagnose and treat are tumors. I find that in most text-books and systems of surgery neoplasms of, and in the region of, the jaws are not given the prominent consideration which their relative frequency and the importance of their treatment demand. On this account, I shall discuss tumors first.

I. TUMORS OF THE JAWS.

General Remarks and Classification.—In considering tumors in this region we must bear in mind the new-growths, both benign and malignant, which spring from the mucous membrane, from the connective tissue, and from the bone. At the same time the special neoplasms which arise from the teeth—the adamantine epithelioma and the dentigerous cyst—should receive consideration; and a certain amount of space must be devoted to the discussion of the intranasal, naso-pharyngeal, orbital, and temporal-fossa tumors.

The accessory sinus called the "antrum" is practically the medullary cavity of the upper jaw, and all of its diseases are included in lesions of this structure. While Dr. Mosher, who is a specialist in diseases of the nose and throat, has already (page 52 *et seq.*) considered in detail the diseases of the nasal cavity and the accessory sinuses, he has done so with the understanding that upon me would rest the responsibility of discussing some of the lesions of these cavities more strictly from the view-point of the general surgeon.

Fractures of the jaws have been discussed in Vol. III. (pp. 102 to 107). In treating this subject again in the present article I purpose to discuss more particularly the etiological relationship between such injuries and new-formations, and also the prevention and treatment of osteomyelitis and antrum infections due to wounds in the neighborhood or to compound fractures of the jaws.

In the differential diagnosis between inflammatory and neoplastic growths of the jaws one cannot be governed entirely by the general principles which apply to the differential diagnosis of tumors and inflammations elsewhere. The same tumors and inflammations in the region of the jaw present certain special clinical features and one must have a large clinical and pathological experience to make the proper diagnosis and to subject the patient to the most appropriate treatment. I shall endeavor, in this article, to utilize the records of an unusually large material which has accumulated since 1892 in the surgical pathological laboratory of the Johns Hopkins Hospital, and which I have had the opportunity to study in detail, both clinically and pathologically. The majority of these cases have been treated in the surgical clinic of Professor Halsted. I have also enjoyed unusual opportunities for familiarizing myself with the ultimate results of the operations which have been undertaken for the relief of these conditions. The experience which I had gained up to April, 1903, was published at that time in pamphlet form. It was based upon eighty examples of tumors and sixty-six of inflammations. Since then the total number of cases has almost doubled.

For the practical purposes of differential diagnosis and for the elucidation of the technique of the operative treatment, other tumors than those arising from the jaw proper will receive due consideration in a section devoted to the surgery of the maxillary bones. (See farther on, page 866 *et seq.*)

The following tumors will here be discussed: (1) Those having their origin in the periosteum or medullary cavity of the upper and lower jaws; (2) those which arise in the antrum, the nose, the nasopharynx, the temporal fossa, and the orbit; and (3) those which spring from the mucous membrane of the gum, the lip, the cheek, the floor and roof of the mouth, the tonsil, and the pharynx.

(1) The tumors of the first group are the special neoplasms of the maxillary bones and they are either sarcomata or adamantine epitheliomata, solid or cystic, which have for their origin embryonic remains of the tooth organs.

(2) The tumors of the second group arise in the antrum, the nose, the nasopharynx, the temporal fossa, and the orbit. They are in such close relation to the upper jaw that they must be considered when the subjects of differential diagnosis and of operative treatment are discussed.

(3) The tumors which arise from the mucous membrane of the gum and the surfaces of the lip, cheek, floor and roof of the mouth, tonsil, and pharynx are epithelial in character. They rapidly invade the maxillary bone, and must be constantly differentiated from primary tumors of the bone.

The technical problems which present themselves in the course of operative treatment are the same for all three classes.

CLASSIFICATION OF TUMORS OF THE JAWS (BOTH PRIMARY AND SECONDARY).

I. Tumors arising from the upper or the lower jaw.
    A. Primary tumors of the alveolar border.
        1. Ossifying periostitis and exostosis.
        2. Epulis.
        3. Adamantine epithelioma.
        4. Benign and malignant epithelial tumors.
        5. Mixed tumors primarily originating in the parotid gland.
    B. Periosteal tumors of the body of the jaw.
        1. Periosteal osteosarcoma.
        2. Periosteal fibromyxochondrosarcoma.
        3. Periosteal spindle-cell and round-cell sarcomata.

- C. Medullary tumors of the body of the lower jaw.
    - 1. Giant-cell sarcoma.
    - 2. Dentigerous cyst and adamantine epithelioma.
- II. Antrum tumors.
    - A. Dentigerous cyst and adamantine epithelioma.
    - B. Fibromyxosarcoma.
    - C. Giant-cell sarcoma.
    - D. Spindle-cell and round-cell sarcoma.
    - E. Carcinoma.
        - 1. Primary in antrum.
        - 2. Primary in nasal mucous membrane.
        - 3. Primary in a nasal polypus.
- III. Tumors of dental origin.
    - A. Dental-root cyst.
    - B. Dentigerous cyst.
    - C. Adamantine epithelioma of alveolar border.
    - D. Solid, and E. cystic, adamantine epithelioma of the body of the jaw.
- IV. Carcinoma of mucous membrane of the mouth and gum, with secondary involvement of the jaw.
- V. Carcinoma of some other mucous membrane than that of the gum, with secondary involvement of the upper or the lower jaw.
- VI. Orbital tumors proper.
- VII. Intranasal tumors.
- VIII. Nasopharyngeal tumors.
- IX. Tumors of the hard and soft palates.
- X. Tumors of the temporal fossa.

The questions which I shall constantly keep in mind are: (1) the differential diagnosis, as ascertained from the clinical features of the case, from the gross pathological appearances observed at the time when the exploratory incision is made, and from the picture presented in the frozen section; (2) the nature and extent of the operation which should be undertaken in order to secure a permanent cure with the least mutilation and lowest operative mortality; (3) the recognition of the fact that the tumor, in certain cases, is of such a nature that it can never be cured by operative removal. These are cases in which it is wise not to make any attempt to excise the tumor, but simply to make the patient as comfortable as possible by a resort to such measures as may retard the growth of the disease—as, for example, by ligation of the blood-supply, by the employment of the *x*-rays, and, perhaps, by the use of certain vaccines.

The more or less continuous study of these cases of tumor of the jaw, throughout a period of sixteen years, has led me to adopt the following conclusions:—(*a*) The more malignant tumors, both those of a carcinomatous and those of a sarcomatous nature, have not, so far, been cured by the most extensive and mutilating operations; and the reason for this lack of success is that the local infiltration extends beyond the limit to which one is justified in carrying the process of eradication, or else that metastases already exist. (*b*) The benign and the less malignant forms of sarcoma, the benign and less malignant epithelioma, and especially the dentigerous cysts and the adamantine epitheliomas have been permanently cured as frequently by conservative operations as by more radical and mutilating interventions. It is only in this latter group that cures may be expected. For this reason it is specially incumbent upon the surgeon to train himself in differential diagnosis, so that he may be able to select the cases which belong in this less malignant group and consequently to subject only those patients who have a tumor of this nature to a less mutilating operation.

1. Tumors Arising from the Upper or the Lower Jaw.

A. Primary Tumors of the Alveolar Border. The most common neoplasm in this part of the jaw is a connective-tissue tumor arising from the tissue beneath the mucous membrane and from the bone. This tumor is usually called "epulis," and its most frequent histological picture is that of a giant-cell tumor. Among the lesions which appear as tumors of the alveolar border, but which are not genuine new-growths, we must distinguish, first, the diffuse hypertrophy which is associated with leukæmia (such tumors are very rare); next, the ossifying periostitis; and, last, the inflammatory new-growths. In these last cases partial operation is sufficient.

For the epulides, the adamantine epitheliomata, and those tumors which resemble the so-called mixed tumors of the parotid, local excision is sufficient. These lesions, therefore, must be differentiated from the primary malignant epithelial tumors which originate in the mucous membrane about the teeth or cover the alveolar border of either the upper or the lower jaw, because for the latter lesion there is demanded a wider local eradication combined with an operative removal of the lymph nodes *en bloc*.

Ossifying Periostitis and Exostosis.—The term osteosarcoma should be reserved for that form of periosteal sarcoma in which there is bone formation. The osteosarcoma belongs to the group which may be called "mixed sarcoma" and includes fibro-, myxo-, chondro-myxo-, and myo-sarcoma.

The ossifying periosteal sarcomata or the osteosarcomata do not attack the alveolar border. They have been observed to arise only from the body of the lower jaw. The demonstration, therefore, of a bony growth situated on the alveolar border of the upper or the lower jaw indicates its benignity.

Ossifying periostitis has been observed in all bones. The most frequent etiological factor is syphilis. In the jaw the disease is looked upon as more frequently the result of a pyorrhœa alveolaris. (Turner, *Practitioner*, May, 1903, LXX., p. 695.)

Exostoses are either the result of a further growth in a congenital tumor of embryonic origin, or they represent the reactive inflammation (with bone production) secondary to a single trauma or to repeated small traumas.

In the jaw exostoses are rare lesions. They are not at all difficult to recognize, and one should not perform a mutilating operation for their removal. I have observed the exostosis to appear in the form of bilateral growths (one on each side of the upper jaw) in a colored male aged forty-two. One tumor was of thirteen years' duration, the other of five. The tumors were covered with periosteum, next to which came a thin shell of condensed bone, and then cancellous bone. (Fig. 554.) In a second case I removed—but only partially—a bony growth from the left side of the upper jaw, and up to the present time—five years having elapsed—there has been no recurrence. The patient, a girl of eighteen, had observed the growth for one year. This tumor filled the fossa between the prominence of the antrum and the teeth and produced a visible bulging of the skin. In the mouth one could palpate, beneath the normal mucous membrane, a solid bony growth. The surface was rougher than that observed in a dentigerous cyst, and there was no parchment crepitation. At the operation, after dissecting back muco-periosteal flaps and chiselling away part of the bony growth, I removed the periosteum with the scissors, in the hope that a recurrence might thereby be prevented. In these two cases the teeth were normal and at the operation the cavity of the antrum was not opened.

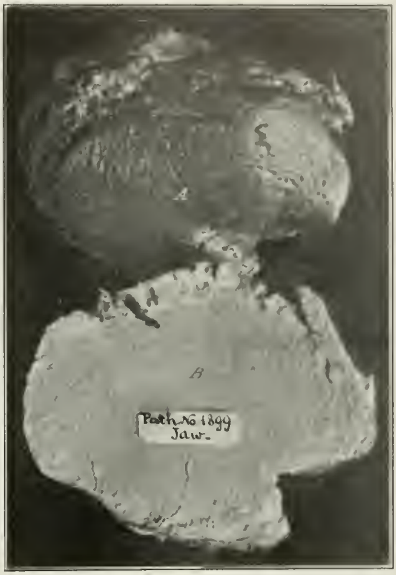


Fig. 554.—Pathol. No. 1899, Johns Hopkins Hospital, Halsted's Clinic. Osteoma of Upper Jaw. Photograph of alcohol specimen. *A*, Skin adherent to tumor; *B*, section through tumor showing condensed cancellous bone.

The ossifying periostitis gives rise to a uniform swelling of the alveolar border, and, in the two cases which I have observed, such a uniform swelling, associated with decayed teeth, extended from canine to molar, on one side of the upper jaw. One of the patients was a negro and the other a white woman, both over forty; in one the swelling had existed for eleven months, in the other for fourteen years.

Unless one is familiar with the disease, ossifying periostitis can be easily mistaken for an osteosarcoma. When the jaw is the part affected diagnosis is aided by the fact that the ossifying sarcoma involves the body of the bone, while the ossifying periostitis is confined to the alveolar border. In both diseases a certain amount of cellular connective tissue lies between the spicules of bone. In the ossifying periostitis this is ordinary young, inflammatory tissue; in the sarcoma it exists in the form of a fibro-spindle-cell neoplasm. The differential diagnosis is important, because in the sarcoma radical excision is demanded, while in the ossifying periostitis this is unnecessary. This disease has been described and pictured by Turner. (*Op. cit.*)

Diffuse Hypertrophy of the Alveolar Border in Leukæmia.—In the patient (a boy of seventeen, who was referred to me by Mitchell, of Washington, D. C.), whose gums are shown in Fig. 555, the symptoms of the disease had existed for about six months. It is interesting to note in this case how deeply the teeth are buried in the swollen gums. The microscopic picture of a section of this swollen tissue shows that beneath the epidermis of the gum (Fig. 556) there is a diffuse growth of lymphoid tissue which resembles, at first sight, lymphosarcoma. The examination of the patient's blood showed acute leukæmia, of the small-lymphocyte-cell type. This possibility must be borne in mind in the differential diagnosis of lesions of the alveolar border of the jaw.

Epulis.—Epulis is a connective-tissue tumor arising from the mesoblastic tissue between the epidermis and the bone of the alveolar border of the jaw, or from the connective tissue surrounding the tooth in its socket.

It is of the utmost importance to differentiate the epulides from the malignant epithelial tumors of the gum. In the case of an epulis, as has been stated before, local excision is sufficient, and this local excision need not be very radical.

Epulis can be differentiated from the more malignant sarcoma of the jaw by means of the difference in the positions of the two tumors; the epulis, like the ossifying periostitis, being strictly confined to the alveolar border.

An epulis is a border-line tumor; it lies midway between inflammation, on the one hand, and a neoplasm, on the other. When looked upon as a neoplasm, it is still a border-line lesion between the benign and the malignant connective-tissue tumors. It is frequently called a sarcoma. I have never known a true epulis to give rise to metastases. Epulis may recur, in the same manner as a keloid does or as adenoids do, but I am of the opinion that the recurrence of an epulis differs from that of a keloid; it is due to incomplete removal.

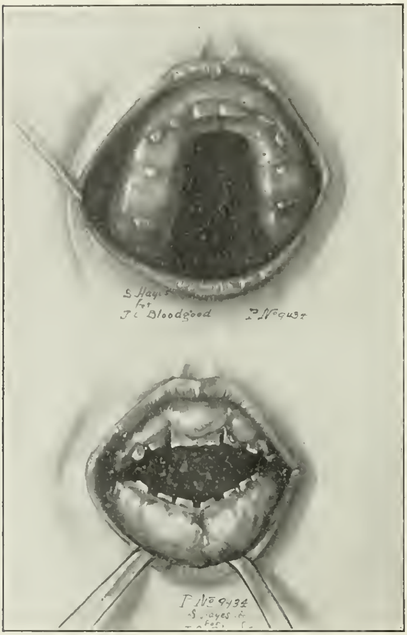


FIG. 555. Pathol. No. 9434. Author's Case. Diffuse Hypertrophy of Alveolar Border of Upper and Lower Jaws due to Acute Leukæmia. (Sketch by Miss Hayes.)

Epulis is a curable tumor. Among a total of about forty cases I have never observed a death. All the patients subjected to operation, including the cases of recurrence, have remained well. I wish to emphasize this observation, because it justifies the surgeon in attempting the removal of the epulis in children and younger individuals by a very conservative operation, one in which the effort is made to save the teeth if they are present. If the epulis occupies the position of extracted or decayed teeth, it should be removed with a zone of healthy mucous membrane and with enough of the bony alveolar border of the jaw to include the entire bony tooth socket. This is necessary because it has been fairly demonstrated that, even if the epulis does not arise from the tooth socket, it rapidly grows down and into it.

In rare cases the epulis is a congenital tumor. The age at which it usually makes its first appearance varies from eight to sixty years. It occurs most frequently between the ages of twenty and thirty. The jaw may harbor an epulis for a period of several years. The tumors of this character which persist for over ten years are usually fibromas or angiofibromas, but those which belong to the giant-cell variety, and which are noticeably vascular, have been known to remain for a period of four years without destroying the bone.

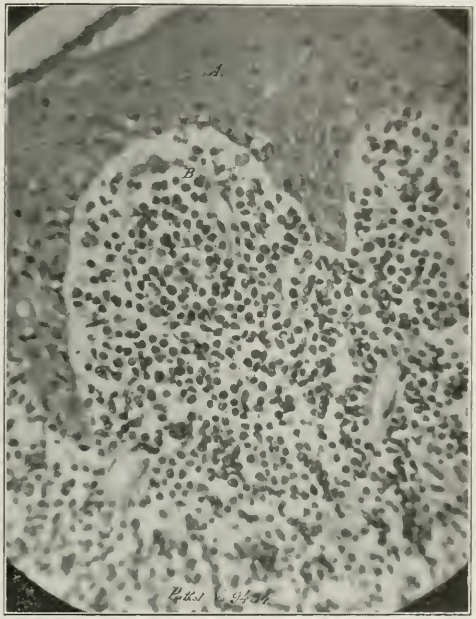


Fig. 556.—Pathol. No. 9134, Author's Case. Photomicrograph (by Schapiro) of Section of Tissue Removed in Case Shown in Fig. 555. *A*, Epidermis; *B*, small lymphoid cells in subepidermal tissue.

Males and females are about equally attacked; but the epulis—unlike what happens in all other kinds of jaw tumors—is less frequently observed in the colored race. (Less than ten per cent of these cases occur among negroes.) In many instances the epulis arises in the region of a decayed tooth or an old root, or it develops after the extraction of a tooth. But this does not always happen.

The epulis may arise from the gum surrounding perfectly normal teeth, and when this is the case it will generally be found that the tumor is a fibroma or an angiofibroma. The giant-cell sarcoma, on the other hand, more often develops from the region of a decayed tooth.

Upon its first appearance the epulis is looked upon by its host as a gum boil, and now and then it is incised by a physician in the belief that it is of this nature. The tumor, however, differs from the infection (the gum boil) in one respect: it is not accompanied by pain and tenderness. Whether the teeth are present or absent, diseased or healthy, the swelling as a rule begins at the inside of the gum, grows down, then across, and involves the other side. The growth on the outer side is never as extensive as on the inner side. If the teeth are present, the growth may surround one or more of them. The epulis never involves the body of the upper or the lower jaw. When the body is involved it may always be assumed that the tumor is of a more malignant character—a sarcoma;—and then an extensive local resection is the only proper treatment to adopt. At what period an epulis may change its original nature and become converted into a malignant periosteal or medullary sarcoma of the jaw, I am not prepared to say; but when it is found that the body of the jaw is the seat of a tumor which looks somewhat like an epulis, one may assume at once that this tumor is not an epulis.

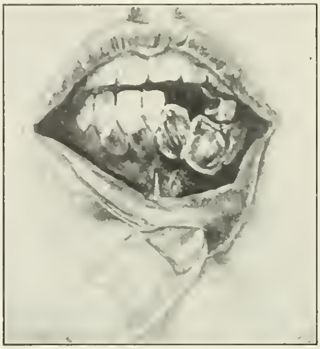


FIG. 557.

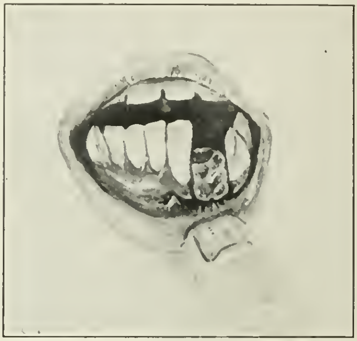


FIG. 558.

FIG. 557.—Pathol. No. 8324. Author's Case. Recurrent Epulis (Angiofibroma) in a Boy of Ten.

FIG. 558.—The Same Case as that Shown in Fig. 557. The picture represents a second recurrence. No teeth were extracted. (The disease has now remained cured for three years, after the use of the Paquelin cautery.)

I have never known an epulis in either jaw to be situated beyond (posteriorly to) the last molar tooth.

At first the epulis is covered with mucous membrane, except in those cases in which the tumor arises from the region surrounding a decayed tooth or from the excavation left by the extraction of a tooth. In such instances there is a small defect corresponding to the tooth cavity.

The epidermis covering the epulis may be destroyed and an ulcer may form. If the tumor is a fibroma such ulceration is of less frequent occurrence and it is associated with very little hemorrhage. In the fibro-angiomatous epulides hemorrhage may be profuse; in the giant-cell tumor, when ulceration takes place, the hemorrhage is slight, but quite continuous.

In Fig. 557 is shown a fibro-angiomatous epulis in a boy of ten, not associated with decayed teeth. At the first operation one incisor was extracted with the tumor. The recurrence is shown in Fig. 557; the tumor not only involves the defects, but surrounds the canine. I removed this tumor with the knife and did not use the Paquelin cautery. It recurred subsequently. (Fig. 558.) This new recurrence was treated with the Paquelin cautery with a favorable result up to date—three years after operation. This and other observations of my own indicate that the instrument of choice in the conservative removal of epulides is the Paquelin cautery. This case also demonstrates that a tooth may be saved. Figs. 559, 560, 561 illustrate the gross and microscopic appearances of a giant-cell epulis; Fig. 563 shows those of a fibromatous epulis.

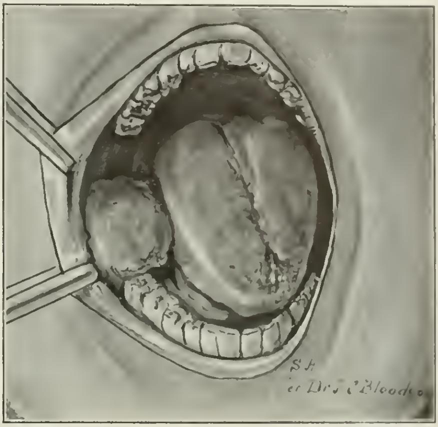


FIG. 559. Pathol. No. 9121 Author's Case. Giant-cell Epulis of Right Lower Jaw; painless growth three years in white male aged fifty The last two molars have been lost, after the appearance of the tumor.

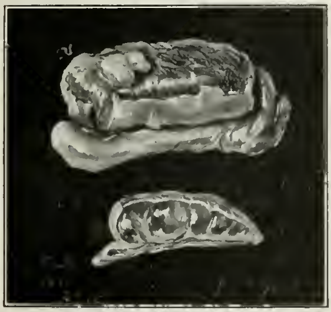


FIG. 560.—Fresh Specimen Showing Section and Surface of Tumor illustrated in Fig. 559—giant-cell epulis.

The other tumors of the alveolar border (adamantine epithelioma, benign and malignant epithelial tumors, and mixed tumors) will be discussed farther on in this article.

B. Periosteal Tumors of the Body of the Jaw.—These tumors differ from the primary tumors of the alveolar border in one respect, viz., the body of the jaw, upper or lower, is involved alone, or in addition to the alveolar border. The ossifying periostitis which possibly may accompany an osteomyelitis of the jaw, should be considered as having very much the same significance as an involucrum about a sequestrum. The clinical and pathological picture presented by such a periostitis will be considered when I come to discuss the subject of osteomye-

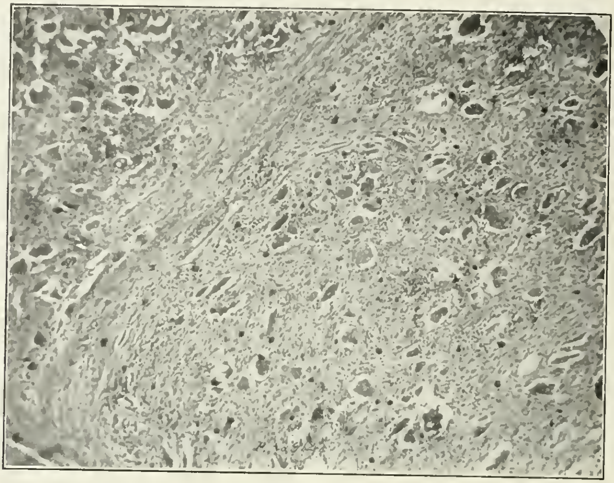


FIG. 561.

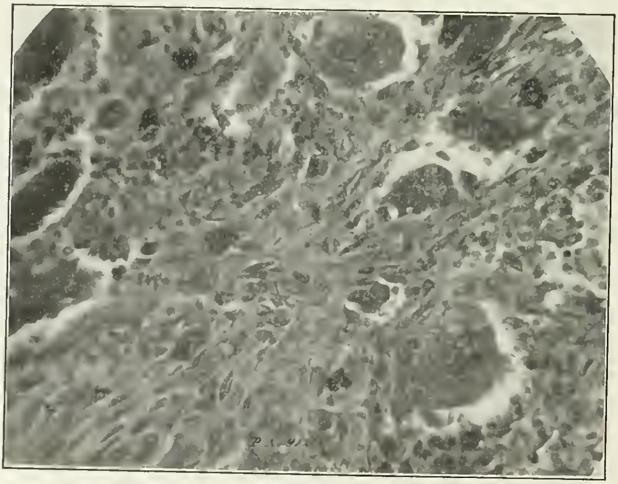


FIG. 562.

FIGS. 561 and 562.—Pathol. No. 9124. Author's Case. Photomicrographs (by Schapiro) of Giant-cell Epulis Shown in Figs. 559 and 560. Fig. 561 represents a low-power view, Fig. 562 one in which the details are more highly magnified.

litis of the jaw. It possesses such distinctive features that it should never, as it seems to me, be mistaken for a new-growth.

Periosteal tumors, considered from a pathological standpoint, irrespective of the particular bone from which they arise, may be divided into three great groups. These groups are: the mixed sarcoma, the simple cellular sarcoma, and the angiosarcoma. The first group—the mixed sarcoma—consists of cellular tumors, in which, in addition to the cellular part (undifferentiated spindle and round cells), bone, cartilage, and fibrous tissue or myxomatous tissue, are formed. I wish to emphasize this group because the tumors which it comprises are, like the giant-cell sarcoma, relatively less malignant than the cellular sarcomata and the angiosarcomata. They can be cured by a fairly restricted local operation. The mutilation necessitated by the operative intervention is therefore governed by the extent of the tumor's local growth and not by its malignancy. Furthermore, the tumors belonging to this group are of rather frequent occurrence (as periosteal tumors of the jaw or as tumors which originate in the antrum and then extend to other parts of the jaw), and they represent the only forms of sarcoma of the jaw (aside from the epulides) which are curable.

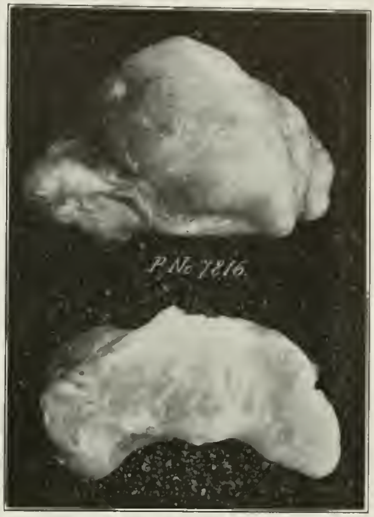


Fig. 563.—Pathol. No. 7816. Author's Case. Epulis: Œdematous Fibroma. Photograph (by Schapiro) of fresh specimen. (× 2 diameters.)

The simple cellular sarcoma which represents various combinations of spindle and round cells, and the angiosarcoma, either perithelial or endothelial, are the most malignant forms of sarcoma. Up to the present time I have never observed, nor have I seen recorded in the literature, any example of a positive cure of a sarcoma of either the upper or the lower jaw which belonged in this group of the more malignant sarcomata, and that, too, notwithstanding the fact that in a number of instances the most radical mutilating extirpation had been carried out. These facts, based upon a very large experience, govern the operative procedures which I will discuss later for all malignant tumors of the jaw.

So far as the jaws are concerned, the only instances of periosteal sarcoma which I have observed involved the lower jaw. In the upper jaw tumors of similar pathology have been observed only in the antrum. Of the periosteal sarcomas of the lower jaw fifty per cent (five cases) were of the less malignant type, and all of these patients have remained well except one, in whom death was due to operative interference.

One is justified, therefore, in performing a somewhat restricted operation for the periosteal osteo-, fibro-, and myxo-sarcomata.

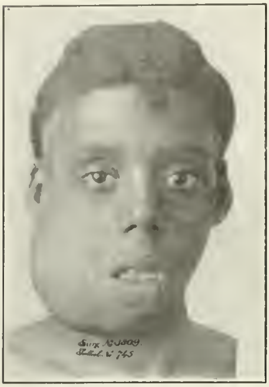


Fig. 564.—Pathol. No. 745, Johns Hopkins Hospital, Halsted's Clinic. Periosteal Osteosarcoma of Right Lower Jaw. Colored girl, aged twenty-four years. Pain three years; swelling of jaw three and one-half months. Resection; patient has remained cured eleven years.

Periosteal Osteosarcoma.—In periosteal osteosarcoma there is a uniform swelling of the body of the lower jaw from angle to symphysis. (Fig. 564.) On palpation, although the tumor feels hard, it does not convey the smooth, tense sensation of a shell of bone, nor the ping-pong crepitation of a dentigerous cyst. It is a rough, irregular swelling which, when palpated, feels somewhat like that produced by an ossifying periostitis. In the two cases which I have observed, the alveolar border has been free. One or two teeth were absent, and at the spots which they once occupied there were slight ulcerations. The new-growth (Fig. 565) consists of new bone formation, which extends between the shaft and the thickened periosteum. Between the new bone formation and the shaft of the jaw there is cellular tissue, and this tissue appears to have forced its way into the shaft. The architectural features of the newly formed bone and of that part of the original bone which had been destroyed are well illustrated in the *x*-ray picture of the specimen. (Fig. 566.) In all the cases of periosteal osteosarcoma which I have observed, the cellular tissue between the newly formed bone and the original bone has presented the appearance of the tissues which compose the less malignant spindle-cell fibrosarcoma or the fibro-

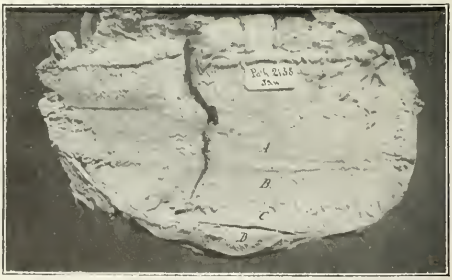


Fig. 565.—Pathol. No. 2138, Johns Hopkins Hospital, Halsted's Clinic. Periosteal osteosarcoma. Photograph of section through gross specimen. Colored girl, aged thirteen. Tumor nine weeks; resection; patient has remained cured eleven years. *A*, Body of jaw; *B*, ossifying zone of sarcoma; *C*, cellular zone of sarcoma; *D*, capsule of thickened periosteum.

myxosarcoma; and the patients affected with periosteal osteosarcoma of some other bone than the jaw) who have come under my observation have also remained well after removal of the tumor.

Periosteal Fibrosarcoma or Fibromyxosarcoma.—Tumors of these species are observed on the jaw about as frequently as is the osteosarcoma; but it is an interesting fact that they are rarely observed on other bones. When the lower jaw is the seat of the tumor the appearances presented are somewhat different from those presented by an osteosarcoma in the same locality. (Fig. 567.) For example, it is less apt to surround the entire body of the jaw. Histologically, it is much more cellular than the fibrous epulis. It involves the alveolar border

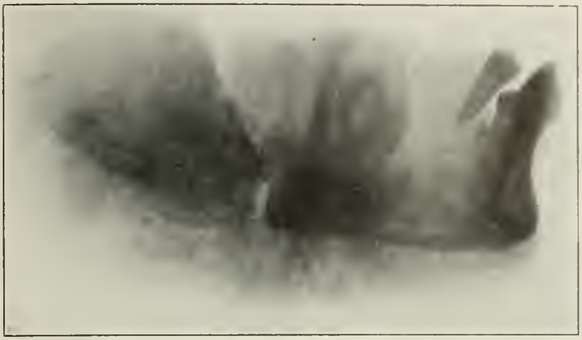


Fig. 566.—*X*-ray Photograph of the Specimen Shown in Fig. 565. (Johns Hopkins Hospital.)

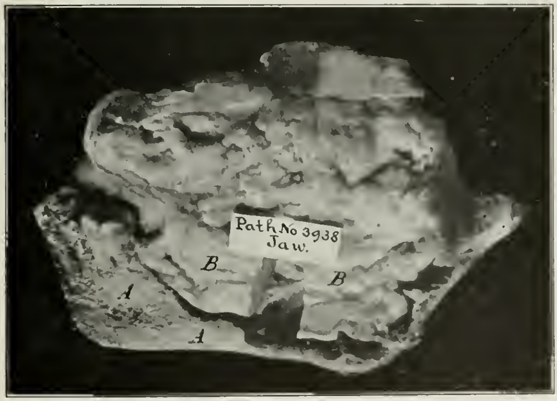


Fig. 567.—Pathol. No. 3938, Johns Hopkins Hospital, Halsted's Clinic. Periosteal Fibromyxosarcoma. Photograph of section through gross specimen. Colored girl, aged eighteen; tumor one year. Resection; patient remained cured nine years. *A*, Jaw; *B*, tumor. Note that the tumor could have been removed without removing the jaw.

in addition to the body, and the teeth are loosened and fall out (an occurrence which does not appear to take place in the periosteal osteosarcoma); but there may be no ulceration.

Periosteal Spindle-Cell-and-Round-Cell Sarcoma.—In a large experience with these cellular neoplasms I have been impressed with the rapidity of their growth and with their malignancy. The chief characteristic of their malignancy is the early formation of metastases. But when one of these tumors involves the lower jaw in the form of a periosteal growth, it is usually seated at the angle and extends up over the ramus, while the less malignant osteosarcoma and fibrosarcoma attack the body of the jaw. On account of these anatomical relations the spindle-cell-and-round-cell periosteal sarcoma of the lower jaw rapidly becomes inoperable.

The age of the patients has varied from twenty-five to forty-nine, while all of the less malignant forms of periosteal sarcoma, with one exception, were observed in individuals younger than twenty-five. These tumors grow more rapidly than the osteosarcoma and the fibrosarcoma, and, if ulceration and loosening of the teeth have not already taken place, they quickly follow the appearance of the growth.

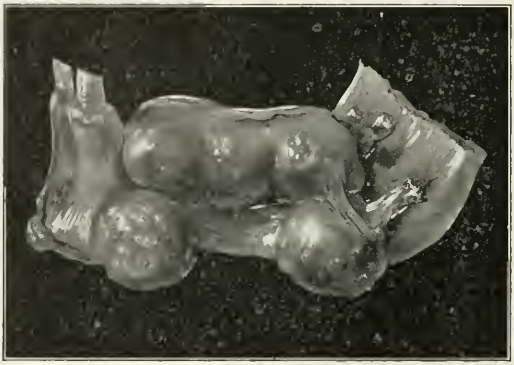


Fig. 568. Pathol. No. 8649 Patient of Fisher Union Protestant Hospital. Periosteal Round-cell Sarcoma of Lower Jaw. White male, aged forty-nine. Symptoms of onset: loose teeth eleven months; two weeks later, swelling. Extraction of teeth relieved neither swelling nor pain; exploratory incision by dentist was followed by more rapid growth. The very cellulur new-growth surrounds the body and ramus of the jaw. Rapid local recurrence and death.

Whether it be possible, or not, to cure these very malignant tumors by operative interference of a radical nature before infiltration has extended too far, I have no evidence to offer.

A swelling of the alveolar border or the body of the lower jaw should be investigated at once. This investigation should be made in an operating-room, so that the surgeon may have within reach all the facilities required for proceeding with whatever operation he may deem necessary. Dentists, who undoubtedly see many of these cases first,—as shown by my own records and by the published reports,—should not explore these swellings, but should seek a consultation with a surgeon. When an exploratory incision is made there should be no difficulty in distinguishing the less malignant periosteal sarcoma (which is either ossifying, fibrous, or myxomatous) from the cellular, succulent, friable spindle-cell-and-round-cell sarcoma. In the case of the former (the less malignant tumor) the operation, although it should be complete, need not extend very far beyond the limits of the capsule of the new-growth; but, in that of the more malignant sarcoma, a wider berth should be given. At the same time, even in this tumor the local resection need not be as radical as in carcinoma, because, in the case of the spindle-cell-and-round-cell sarcoma and the angiosarcoma the fatality is due to metastasis rather than to extensive local infiltration.

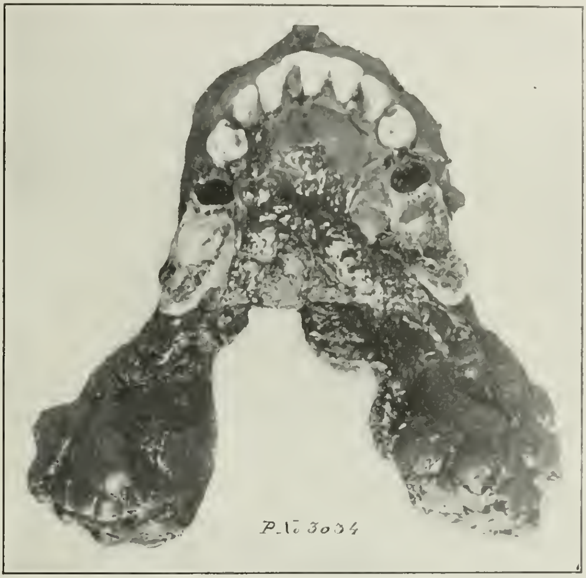


Fig. 569.—Pathol. No. 3034, Johns Hopkins Hospital, Halsted's Clinic. Medullary Giant-cell Sarcoma Arising in Symphysis of Lower Jaw. Photograph of gross specimen. White female, aged twenty-one years. Tumor ten months; patient has remained cured nine years.

Fig. 568 is a sketch of the very malignant round-cell sarcoma in which earlier intervention was distinctly indicated. The dentist should not have extracted the teeth nor have made the exploratory incision. Loosening of teeth followed by swelling of the alveolar border of the body of the jaw, means, with few exceptions, tumor formation, but not necessarily a malignant tumor. Although the most frequent symptom of onset in the very malignant periosteal sarcoma, yet it may be the first sign of a benign dental-root cyst.

C. Medullary Tumors of the Body of the Lower Jaw.—The swellings, which, in most instances, represent the beginnings of a medullary tumor of the lower jaw, originate from dental residues, dental-root cysts, the dentigerous cysts, and the solid and cystic adamantine epitheliomata (lesions which will be discussed farther on under a separate heading).

Giant-Cell Sarcoma.—I have observed the giant-cell sarcoma of the lower jaw (Plate XXXVII, Figs. 1, 2, and 3) three times. In each instance it presented the appearance of a medullary growth. The three patients who were thus affected have remained well now for periods varying from three to ten years, and I am quite confident that an equally successful result would have been obtained had a less radical operation been performed. Fig. 569 shows the specimen removed from one of the cases just mentioned. The tumor, in this instance, was distinctly circumscribed by a fibrous or bony capsule. If an exploratory incision had been made (in the case of the patient from whom the tumor shown in Fig. 569 was removed), there would have been no difficulty in establishing the diagnosis of a giant-cell sarcoma. This tumor has a peculiar color and consistency in its fresh state. (Plate XXXVII, Figs. 1, 2, 3.) A section made from a rapidly frozen portion of the tumor will reveal the presence of a large number of giant cells. (See Figs. 561 and 562.) The starting-point of the tumor was the medullary cavity of the symphysis, and in its further growth it bulged toward the tongue, ultimately filling the space between the tongue and the lower jaw. I have cured a tumor of this character by the simple operation of curetting. It filled the entire upper third of the medullary cavity of the tibia. (*Johns Hopkins Hosp. Bull.*, Vol. XIV., May, 1903, p. 134.)

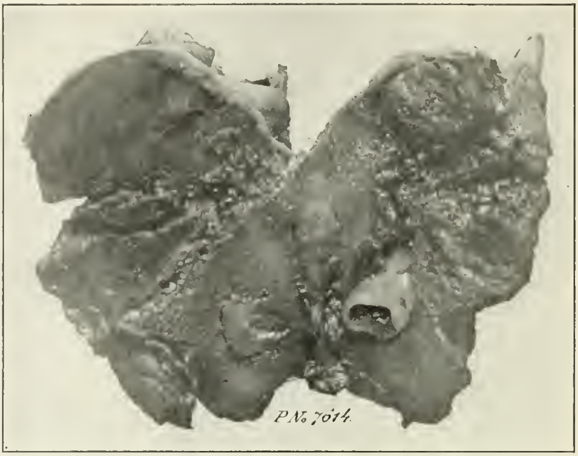


Fig. 570.—Pathol. No. 7614, Johns Hopkins Hospital, Halsted's Clinic. Medullary Giant-cell Sarcoma of Lower Jaw. Photograph of gross specimen, showing tumor surrounding non-erupted tooth. White male, aged ten years; tumor three months. Resection; patient remained cured three years.

EXPLANATION OF PLATE XXXVII.

Figs. 1, 2, 3.—Medullary Giant-Cell Sarcoma of the Lower Jaw. White male, aged ten years; tumor three months; swelling of symphysis, and to the right involving the floor of the mouth toward the tongue. (Pathol. No. 7614, Johns Hopkins Hospital.)

Fig. 1.—*Upper:* the piece resected; *lower:* the gross appearance of a section through the tumor.

Figs. 2 and 3.—Sections through Symphysis, showing bony capsule and non-erupted tooth buried in tumor tissue. Curetting would have been sufficient for this tumor. (See also Fig. 570 in the text.)

Fig. 4.—Nasopharyngeal Fibrospindle-Cell Fibrosarcoma. Surface view and sections through tumor. White boy, aged twelve years; symptoms seven months. For clinical appearance see Fig. 606 in the text. (Pathol. No. 7443, Johns Hopkins Hospital.)

Fig. 5.—Metastatic Carcinomatous Lymph Node. Originated from a carcinoma of the upper jaw which began as a nasal polypus. White male, aged forty-two years; symptoms of nasal obstruction with hemorrhage eleven months. There had been three operations for nasal polypi; swelling of antrum five months. Inoperable. Duration of disease fourteen months. (Pathol. No. 5964, Johns Hopkins Hospital.)

Fig. 6.—Adamantine Epithelioma of Alveolar Border of Lower Jaw. For further details see legend of Fig. 587, on page 841.

Fig. 7.—Gross Appearance of a Medullary Carcinoma of the Upper Jaw, primary in antrum. White female, aged sixty-two years; symptoms four months; almost complete absorption of bony capsule. Considered inoperable. Death seven months later. Total duration of disease eleven months. The diagnosis of cellular carcinoma was made from the piece shown in the illustration. (Pathol. No. 6229, Johns Hopkins Hospital.)

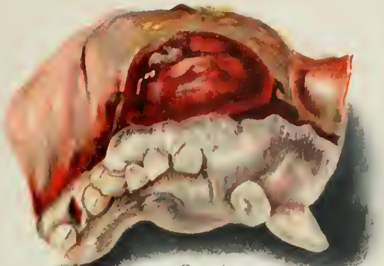
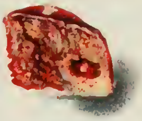


FIG 1



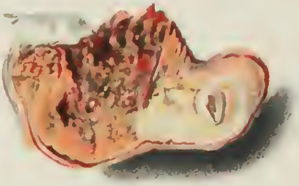


FIG. 2

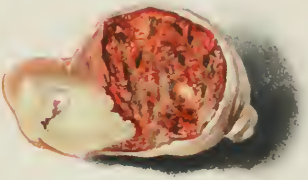


FIG 3

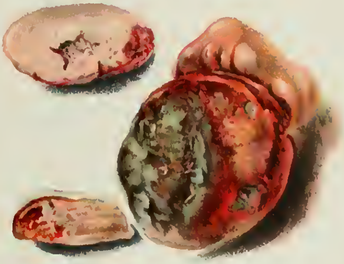


FIG. 4

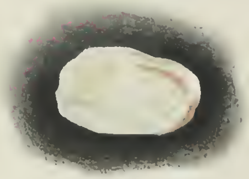


FIG 5

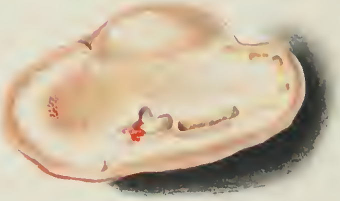


FIG 7

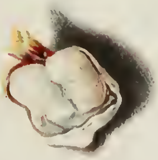


FIG 6

CARCINOMA AND SARCOMA OF THE JAWS AND NEIGHBORING PARTS.
(BLOODGOOD.)

GEO. H. WALKER & CO. BOSTON

Fig. 570 is of interest, because the giant-cell growth expanding the lower jaw to the right of the symphysis surrounds a non-erupted tooth. In this case the relative benignity of the neoplasm could have been recognized at an exploratory incision.

Figs. 571 and 572 are introduced here to demonstrate that the giant-cell sarcoma may arise from the body of the jaw, at some distance from the symphysis. The evidence which has accumulated up to this time with regard to giant-cell sarcomas should justify one in doing a very much less radical operation than was done in the case here referred to.

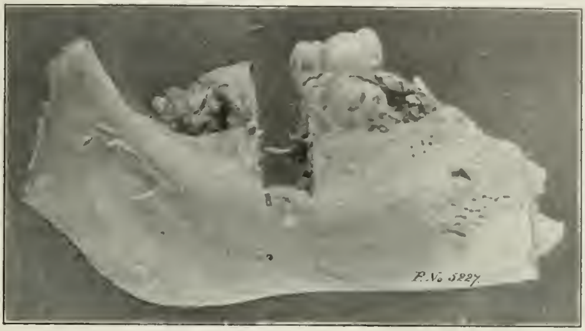


Fig. 571.

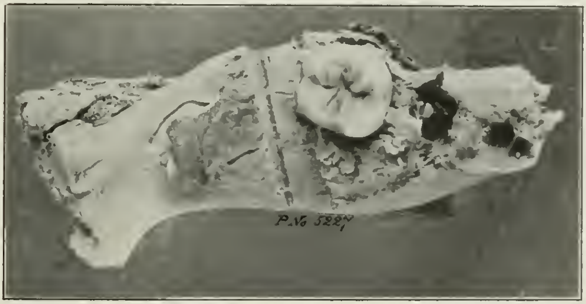


Fig. 572.

Figs. 571 and 572.—Pathol. No. 5227. Patient of Dr. Lund of Boston. Giant-cell Sarcoma Involving Body of Lower Jaw. Patient has remained cured three years since operation. Fig. 571 shows a side view of the Jaw; Fig. 572, a view from above.

Blauel, in discussing central fibromata of the jaw, mentions the possibility also of giant-cell sarcomas.* Both are rare tumors. The case illustrated by Blauel and called by him a central fibroma, corresponds to the one illustrated here in Fig. 567. I am of the opinion that both are periosteal fibrosarcomas.

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*Beitraege z. klin. Chir., 1903, vol. xxxvii., p. 306.

II. ANTRUM TUMORS.

As the antrum is lined by mucous membrane we may have, originating in this cavity, besides all possible benign and malignant connective-tissue tumors, also epithelial tumors.

I have never observed in the antrum, nor have I seen recorded in the literature, any examples of ossifying periostitis or of exostosis, nor have any cases of the so-called mixed tumors of the parotid been observed to originate in the antrum. With these exceptions the possible tumors already described as originating from the alveolar border or the periosteum of the jaw, or from the medullary cavity of the lower jaw, have been observed in the maxillary sinus.

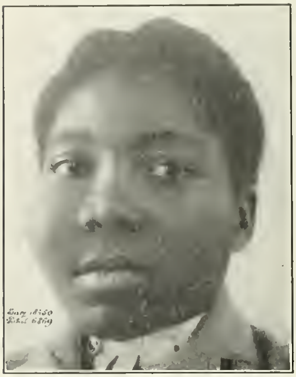

FIG. 573.—Pathol. No. 6869, Johns Hopkins Hospital, Halsted's Clinic. Fibromyxosarcoma of Antrum. Colored girl, aged seventeen years; tumor nineteen months. Preservation of shell of bone with ping-pong crepitation suggested dentigerous cyst. The long duration and absence of infiltration beyond bone capsule afforded evidence against a malignant tumor. Resection; patient has remained cured for three years. (See Plate XXXVIII, Fig. 1, *a*, *b*, *c*, for tumor removed.)

The statements made on a previous page about the relative degree of malignancy of the different new-growths apply here, and so also do the principles there formulated with reference to the question of operating.

Of the sixteen cases of primary connective-tissue antrum tumors observed, seven belong to the less malignant group. One of these was a giant-cell sarcoma; the remaining six were fibrosarcomas or fibromyxosarcomas. In all of these cases, the patients, with a single exception (death from shock), have remained well since operation.

A, B, and C.—Dentigerous Cyst; Fibrosarcoma and Fibromyxosarcoma; and Giant-Cell Sarcoma.—In the beginning of their growth these different kinds of tumors have the same clinical symptoms as the very malignant spindle-cell-and-round-cell sarcomata and the carcinomata have. I wish to lay special stress upon the fact that, in the onset, every tumor arising in the antrum produces bulging and, as a rule, is associated with pain. The bulging is first observed in the cheek (Fig. 573) and then later in the palate. Exophthalmos is a late symptom, but it does not belong exclusively to tumors of the present group. I have observed it, for example, in a case of relatively benign fibromyxosarcoma, in one of a very malignant spindle-cell-and-round-cell sarcoma, and in one of a carcinoma. Exophthalmos, therefore, although suggestive of the more malignant tumors, is not a sufficiently trustworthy symptom to be depended upon. Unless a blood-test can be obtained, or unless an exploratory incision be made, will not do, in the early stage of the swelling, to risk a diagnosis.

The age of onset, in the cases of fibromyxosarcoma, has been found to vary from three to seventy-three years; and in those of the spindle-cell-and-round-cell variety of sarcoma, from sixteen to sixty-two years. In practically all the cases of carcinoma the patients were over forty years of age.

In the case of a fibromyxosarcoma the tumor increases rather slowly in size, and when it is encapsulated it carries with it, as it expands, a thin shell of bone. Consequently it is not possible to differentiate this tumor from a dentigerous cyst, except when an exploratory incision is made. In the more malignant spindle-cell-and-round-cell sarcoma and in the carcinoma the growing tumor more quickly absorbs the shell of bone and infiltrates both the soft palate and the tissues of the cheek. When this infiltration is observed, one can feel confident that he is dealing with one of the more malignant forms of tumor and that an operation is not advisable. At the exploratory incision, best made through the cheek, one will be able to recognize the true nature of the different tumors and to act in accordance with this knowledge. Thus, for example, the removal of a piece of the shell of bone reveals the presence of a dentigerous cyst—a lesion which requires drainage only. If a solid tumor is found, and if it proves to be a fibromyxomatous sarcoma, its removal can usually be effected without inflicting damage of a serious character upon the hard palate and the alveolar border of the jaw. If, finally, the tumor prove to be a giant-cell sarcoma—a very rare form of tumor—it will probably be found practicable to cure the disease by curetting and by the subsequent application of the Paquelin cautery. The appearances presented by the spindle-cell-and-round-cell sarcoma and the carcinoma are radically different. For these tumors one would have to perform a very radical excision, but up to the present time I have never observed a cure, nor have I found one recorded in the literature.

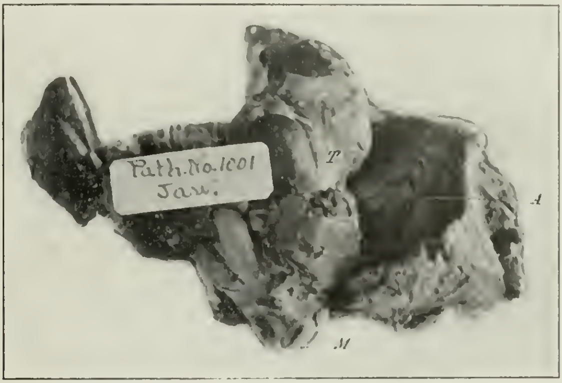

FIG. 574.—Pathol. No. 1001, Johns Hopkins Hospital, Author's Case. Encapsulated Fibrospindle-cell Sarcoma of Antrum. Photograph of alcohol specimen. This tumor could have been completely removed without including the bone shown at *A*. White male, aged twenty-five years. Tumor ten months; excision of upper jaw; patient has remained cured fourteen years. *T*, Tumor. *A*, antrum with alveolar border of jaw; *M*, molar tooth.

Fig. 574 illustrates how completely encapsulated these fibromyxomatous tumors may be. The fibro-spindle-cell tumor is more easily differentiated from the cellular sarcoma than is the fibromyxoma.

Plate XXXVIII (Fig. 1, *a*, *b*, and Fig. 2) illustrates the tumor which was removed from the patient exhibited in Fig. 573. This tumor is so encapsulated that it might easily have been enucleated from the antrum without destroying the bony wall of the hard palate or the alveolar border of the upper jaw.

Very infrequently the antrum, when it is the seat of the relatively benign fibromyxosarcoma (Plate XXXIX, Figs. 1 and 2), may become infected and then rupture spontaneously through the cheek. I mention this possibility, because it has been looked upon in the past as a complication which belonged particularly to the more malignant sarcoma and the carcinoma. Such a condition, therefore, should not prevent the surgeon from exploring the antrum and ascertaining the nature of the tissue which fills that cavity. Blood from the nares, although most commonly observed in carcinoma and in the more malignant sarcoma, has been a clinical feature of the fibromyxosarcoma. I have never observed it in a dentigerous cyst.

John C. Munro* reports a very interesting case of psammoma of the maxillary sinus. Tumors of this nature are found, as a rule, only where the dura of the meninges is present. Psammomata are not of rare occurrence in the orbit, but Munro's case in the maxillary sinus is unique. Four years have elapsed since the operation and the patient remains free from a recurrence.

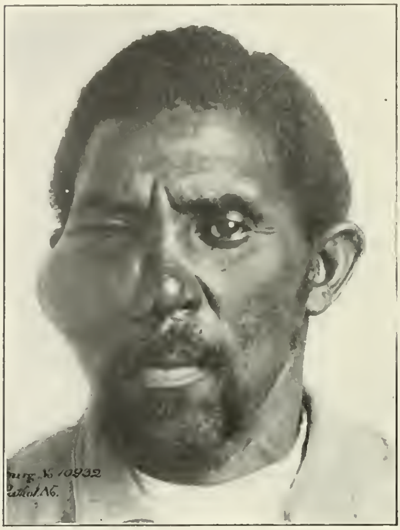

FIG. 575.—Surg. No. 10932. Johns Hopkins Hospital, Halsted's Clinic. Inoperable Sarcoma of the Upper Jaw. Clinical diagnosis only. Colored male, aged fifty; pain and swelling of face five months; obstruction of, and hemorrhage from, right naris; bone capsule not preserved; infiltration of soft parts; bulging and fluctuation of palate. Death a few months after admission.

D. Round-and-Spindle-Cell Sarcoma of the Antrum.—Of the four cases subjected to operation three were inoperable, and in the fourth there was a local recurrence within one month after an apparently complete operation. In five cases the picture of malignancy was so distinct (extensive infiltration and the destruction of the bony capsule) that no operation was performed. (Fig. 575.)

E. Carcinoma of the Antrum.—With the exception of the epulides this tumor is the most frequent neoplasm of the jaw. The 25 cases of which

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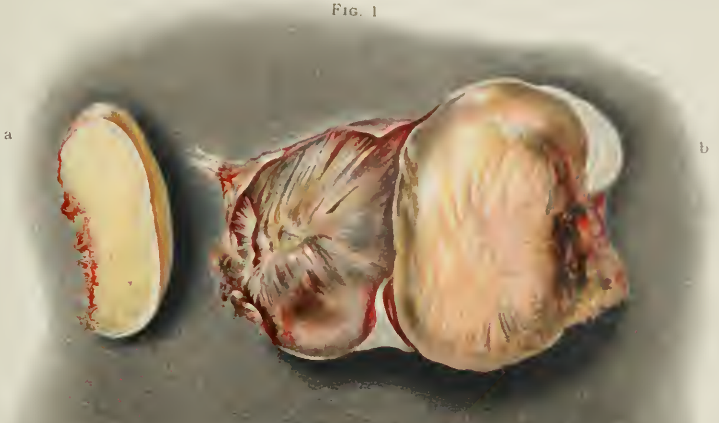
*Med. News, March 4th, 1905.

EXPLANATION OF PLATE XXXVIII.

Fig. 1, *a* and *b*, and Fig. 2.—For details see legend of Fig. 573 in text. These pictures illustrate the pathology of the tumor and demonstrate that it could have been enucleated from the bony capsule. (Pathol. No. 6869, Johns Hopkins Hospital.)

Fig. 3, *a* and *b*.—Carcinoma in a Fibroadenoma of the Lachrymal Gland. *a*, Capsule; *b*, section through tumor. White male, aged sixty-two years; small tumor, of fifteen years' growth; double vision and exophthalmos two years. (Pathol. No. 6163, Johns Hopkins Hospital.)

FIG. 1



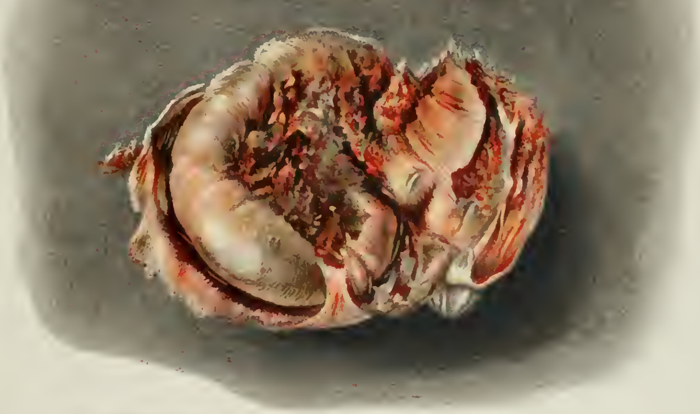


FIG. 2

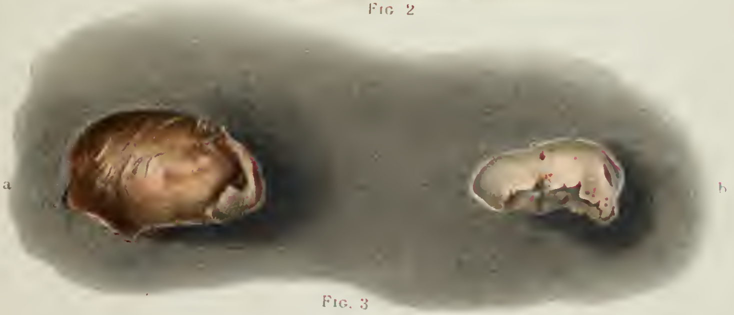


FIG. 3

DENTIGEROUS CYST AND TUMOR OF THE LACHRYMAL GLAND.
(BLOODGOOD.)

I have a record can be classified in three groups: (1) primary carcinoma in the antrum (8 cases); (2) primary carcinoma in the mucous membrane of the nose, with no evidence of nasal polypi (6 cases); and (3) carcinoma associated with nasal polypi (11 cases). In these groups not a single cure is to be reported, despite the most radical extirpation.

The clinical picture and the history are practically the same for primary carcinoma of the antrum as for primary sarcoma. In the late cases the involvement of the lymph nodes in the submaxillary triangle of the neck is evidence in favor of carcinoma. The nature, therefore, of the tumor is not revealed until the exploratory incision discloses it, or until the growth is examined after it has been removed. Theoretically, it should be important to differentiate between the more malignant sarcomas and the carcinoma of the antrum, because in the latter the operation upon the affected lymph nodes should be performed in addition to the local extirpation. But, so far as my observation goes, we have not yet accomplished complete local eradication. Until we shall have learned how to do this, it seems unnecessary to do the operation upon the lymph nodes. I would venture the opinion that if we are to cure carcinoma arising in the antrum, the local operation must be performed before the lymph nodes of the neck are affected, because when infiltration has reached these structures it has certainly extended locally beyond operative intervention.

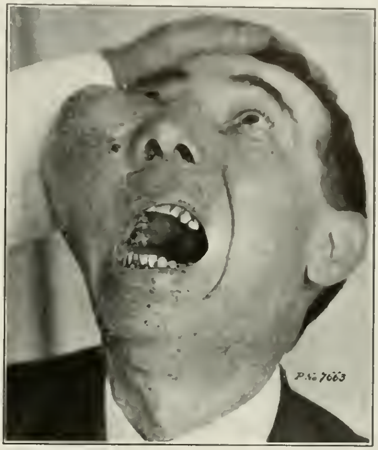


FIG. 576. Pathol. No. 7663, Author's Case. (Photograph by Schapiro.) Carcinoma of Antrum Secondary to Nasal Polypi. White male, aged forty-one years. Nasal polypus; symptoms seven months. When the photograph was taken the disease had been present about one year. The patient died six months later.

Fig. 576 represents clinically the hopeless appearance of carcinoma of the antrum. The exophthalmos, the nasal growth, the bulging of the palate are all pictured. In this case there was, for a time, a temporary arrest of the growth after excision of both external carotids.

The pathology of carcinoma of the antrum is usually that of a medullary carcinoma (Plate XXXVII, Figs. 5 and 7), but in some cases the type of an adenocarcinoma is preserved, and now and then one sees a tumor which closely resembles a papillary adenocarcinoma.

The carcinoma which is secondary to primary growths of the mucous membrane of the nose or nasal polypi will be considered under the heading of Intranasal Tumors (page 855 *et seq.*).

The publication of Stein on statistics and operations of tumors of the upper jaw* covers the ground very completely, and the author agrees with the statements made there, with the exception that he does not come to the same conclusion as regards non-mutilating operations for the less malignant tumors.

III. TUMORS OF DENTAL ORIGIN.

There is great difference of opinion as to the proper classification and nomenclature of these tumors. I will endeavor to present them in the most practical manner, because they are curable lesions and should be differentiated from the more malignant sarcoma and carcinoma. Clinically, both the dental-root cyst and the dentigerous cyst might be mistaken for more malignant tumors, and, if an exploratory incision were not made, an unnecessary mutilating operation might readily be performed. There should be no difficulty in recognizing correctly these two cystic tumors, if an exploratory opening is made. Until one has learned how to recognize it, the solid adamantine epithelioma will frequently be mistaken for the squamous-cell carcinoma. Nine years ago, when I began to make a systematic study of tumors, I was surprised to find a number of permanent cures among patients recorded as having a carcinoma which involved the lower jaw. These patients seemed to be an exception to every rule. But, when the tissues were subjected to a more careful pathological study, it was found that the tumors were not squamous-cell carcinomas, but adamantine epitheliomas. These tumors are relatively common. As regards frequency of occurrence they rank third (*i.e.*, next to carcinoma) among tumors of the jaws. The epulides, as stated before, are encountered more frequently than any other species of tumor.

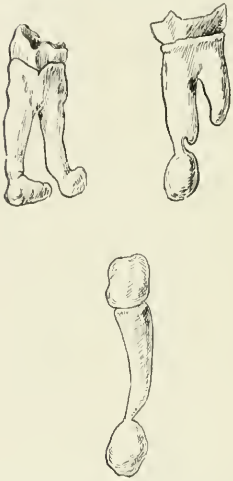


FIG. 577. — Dental-Root Cyst. (From Perthes, in *Deutsche Chirurgie*, Lief. 33 *a*, 1907.)

I do not believe that I am mistaken when I state that it is the prevailing opinion that most tumors of the upper and lower jaws require a bad prognosis. This impression is apparently due to the unfavorable termination of two of the species—carcinoma and the more malignant kinds of sarcoma. For this reason surgeons have either abstained altogether from operating, or else, when they have operated, they have adopted most radical procedures. This condition of affairs has existed for years in a number of clinics. But, if we study carefully the ultimate results, we find, in the first place, as stated before, that there have been no cures among the cases of carcinoma of the antrum or among those of the more malignant sarcoma of the upper and lower jaws; in the second place, that the epulides, the less malignant fibromyxosarcomas, the giant-cell sarco-

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* Archiv f. klin. Chir., 1902, vol. lxv., page 490.

EXPLANATION OF PLATE XXXIX.

Figs. 1 and 2.—Fibromyxosarcoma Originating in Antrum. Colored girl, aged nineteen years; Tumor two years. For clinical appearance see Fig. 573, in the text. Complete resection of upper jaw. Well three years after operation.

Fig. 1 shows the tumor and the upper jaw; Fig. 2, the gross appearance of the tumor.

This tumor could have been enucleated from the upper jaw with preservation of the alveolar border and teeth. (Pathol. No. 7589, Johns Hopkins Hospital.)

Fig. 3.—Malignant Papillary Adenocarcinoma of the Hard Palate. White male, aged seventy years; tumor two years. Excision, local recurrence, and death. This tumor was admitted as a recurrence after an incomplete operation. (Pathol. No. 7854, Johns Hopkins Hospital.)

Fig. 4.—Carcinoma of the Cheek with Secondary Involvement of the Lower Jaw. The new-growth surrounds the entire body of the lower jaw.

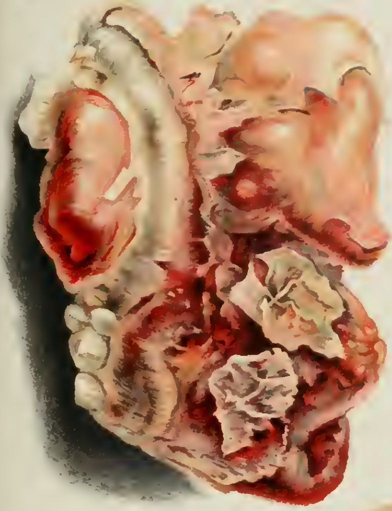

FIG. 1

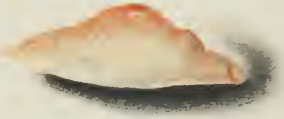

FIG. 2

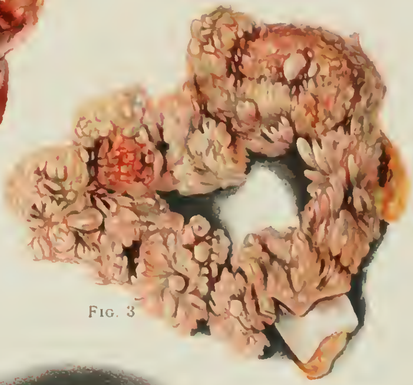

FIG. 3

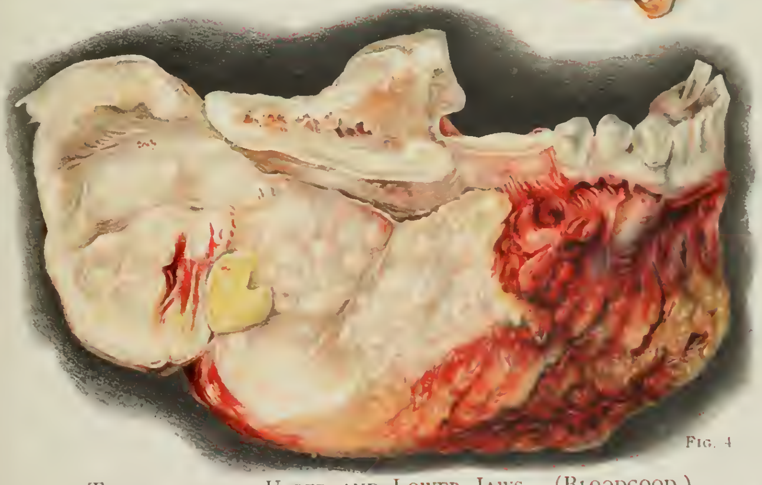

FIG. 4

TUMORS OF THE UPPER AND LOWER JAWS. (BLOODGOOD.)

[illegible]

mas, and the dental tumors have been cured; and, thirdly, that the majority of these patients, owing to the erroneous belief that they were affected with a more malignant tumor, have been subjected to unnecessary mutilation. I repeat this statement frequently in this communication, because it is the only strictly original part, and because the recognition of this difference in malignancy is most important for treatment.

A. Dental-Root Cyst.—The best description of this lesion of which I have any knowledge is that published by Perthes.* These cysts, it appears, are more frequently observed in Germany than in this country. Partsch, in the course of ten years, observed 200 cases. They arise from the root of a tooth, as shown in Fig. 577, and are usually lined with epithelium. (Fig. 578.) I have observed two cases. Fig. 579 shows the appearance of one of these tumors eighteen months after its presence was first noted. The defect shown in the sketch between the molars is due to the extraction of one of them ten years previously. The visible swelling on the outer side was smooth and tense. There was no bulging of the hard palate, but there was fluctuation in the locality indicated by dotted lines in the illustration. I was of the opinion that this was a dental-root cyst which had originated from the molar extracted some years previously. It occupied this bony socket. At the operation no shell of

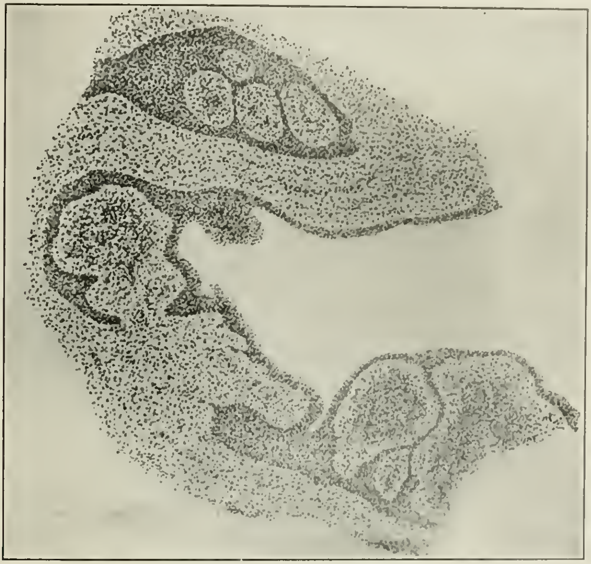

Fig. 578.—Section through a Cystic Root-Granuloma. (From Perthes, in *Deutsche Chir.*, Lief. 33 *a*, 1907.)

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* Deutsche Chir., Lieferung 33 a, 1907.

bone was found, but, instead, a thick connective-tissue wall, which could be separated from the mucous membrane. A yellowish, viscid mucus composed the contents of the cyst. The cavity was curetted and packed. Complete healing took place after a two weeks' course of treatment with pure carbolic acid, followed by applications of alcohol. I did not secure a piece of the cyst wall for study under the microscope.

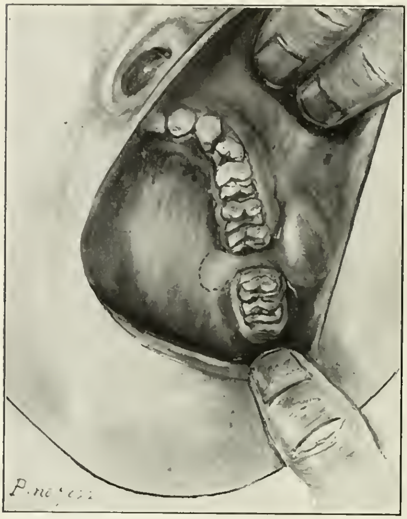

Fig. 579.—Pathol. No. 9022. Author's Case. (Sketch by Miss Hayes.) Dental-root Cyst of Upper Jaw. Male, aged thirty-five years; swelling eighteen months. Patient remained cured one year after curetting.

The second case observed is of greater interest because there were apparently multiple cysts. The patient was a female, aged twenty. The initial symptoms were loosening of the molar teeth and swelling of the gum (like a gum-boil) one year previously. Her dentist was unable to find a cavity in any of these teeth. Fig. 580 is a photograph of a cast from the upper jaw showing the irregularities of the teeth and the bulging of the gum on each side. The first and second molars are out of line and loose; the bicuspid is a little loose, but not out of the line; the bulging is most marked on the outer side; no shell of bone can be made out, but there is distinct fluctuation. The *x*-ray picture (Fig. 581)

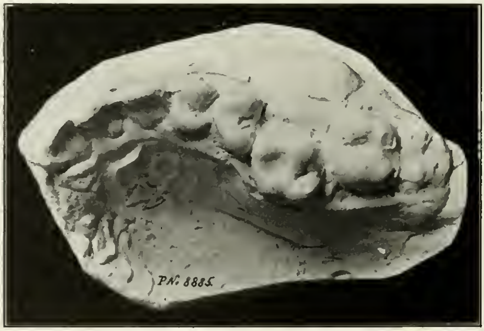

Fig. 580.—Pathol. No. 8885, Author's Case. Photograph of Cast of Upper Jaw Illustrating the Deformity of the Teeth and the Swelling of the Alveolar Border due to a Dental-root Cyst. The cast was made by Dr. Gore.

shows a light shadow between the bony palate and the teeth corresponding to the two molars and the bicuspid. This light shadow is not present on the other side. In the *x*-ray picture there is no evidence of bulging of the palate and there is no non-erupted tooth. At the operation I removed the two molars, which were loose, together with a zone of gum, and thus opened a cavity which contained clear fluid. The deeper portion of the cavity had a thin bony capsule which represented the alveolar border of the jaw. It required seven months of treatment before the epidermis lining the gum met the epithelium lining the cavity and thus covered the defect; but this conservative operation, which necessitated no more mutilation than that which resulted from the extraction of two teeth already loose and useless, apparently cured the disease.

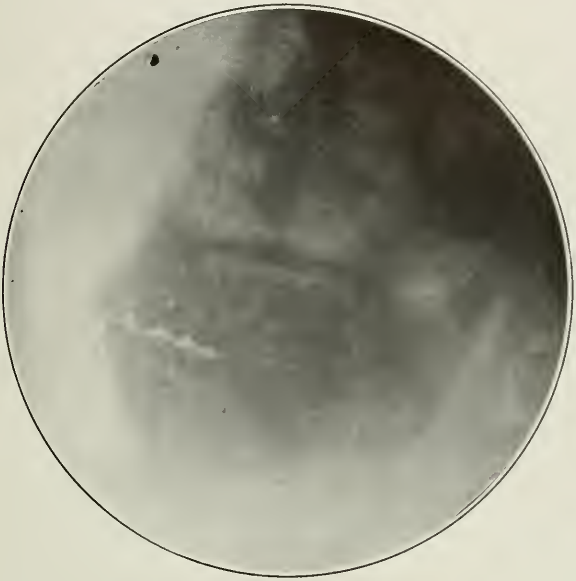

FIG. 581.—*X*-ray Photograph (by Baetjer) of Dental-root Cyst Shown in Fig. 580.

B. Dentigerous Cysts.—I have studied six cases of dentigerous cysts arising in the lower jaw, five in the upper jaw, and two of a similar character arising from the ethmoid. The ages of the patients, at the onset of the disease, have varied from seven to thirty years; the time of the onset, therefore, excludes no other tumor of the jaws except carcinoma. The duration of the dentigerous cyst varied from three months to thirteen years. Except for two patients who died after operation, all have remained free from recurrence up to the present time.

Dentigerous Cysts of the Lower Jaw.—Fig. 582 is a sketch of a dentigerous cyst of the lower jaw which I removed by operation in June, 1896—*i.e.*, almost thirteen years ago. The clinical picture and pathology in this case illustrate well the other cases which I have observed. The patient was a male, fifteen years of age. Three months before operation the right bicuspid on the lower jaw was extracted because it was decayed. One month later the patient observed a swelling on the outer side of the body of the lower jaw. There had been no pain and the wound resulting from the extraction of the tooth had healed. When the jaw was examined no evidence of the last molar could be found. The expansion of the body of the jaw began at the junction of the angle with the body and extended to about the plane of the bicuspid, as shown in the illustration. *There was no enlargement of the alveolar border.* On palpation, parchment crepitation was felt. The diagnosis of a benign cyst was made. At the exploratory incision it was found that the periosteum could be stripped from the bony shell as readily as it can be from normal bone. The shell of bone varied from one to three millimetres in thickness and was lined with a vascular connective-tissue membrane. It contained a blood-stained, serous fluid and a non-erupted molar tooth. The membranous lining and the tooth were removed and the cavity was allowed to close with a blood clot. The healing progressed without any complications, and no deformity resulted. (Fig. 583.) On studying the cyst by aid of the microscope I failed to find any evidences of an epithelial lining. (This case

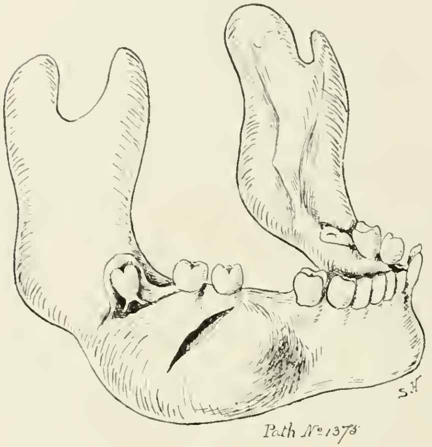

FIG. 582.—Pathol. No. 1375, Author's Case. Schematic Sketch of Dentigerous Cyst of Lower Jaw. White male, aged fifteen years, swelling three months. Partial excision with curetting; patient has remained cured for thirteen years since operation. (See Fig. 583.)

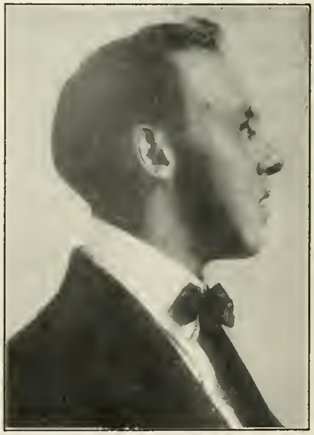

FIG. 583.—Pathol. No. 1375, Author's Case. Photograph shows ultimate result twelve years after operation for dentigerous cyst illustrated in Fig. 582.

was reported in the *Journal of the American Medical Association*, Oct. 15th, 1904.) In the specimen sent to me by Dr. George Barrie, of Washington, the cyst was lined with epithelium of the adamantine type. The cyst itself contained a cloudy fluid like the contents of an atheromatous cyst. (This case was reported by Dr. Barrie in the *Annals of Surgery*, September, 1905.)

There should be no difficulty, as I believe, in making a correct diagnosis, at least when the cyst is open.

So far as treatment is concerned, it is necessary to remove only some of the shell of bone, enough to correct the deformity, and then to evacuate the contents. The membranous lining of the cyst, if not infected, should be removed by means of the curette and then the cavity should be closed. If the shell of bone is removed subperiosteally, the periosteum, when pushed back into the excavation, will form new bone and fill the cavity. This took place in the case illustrated in Fig. 584. If the cyst has ruptured, or if a tooth communicating with the cyst has been extracted,—which procedure can scarcely fail to produce infection of the cavity,—the latter should not be closed, but should be drained or packed according to the degree of the infection.

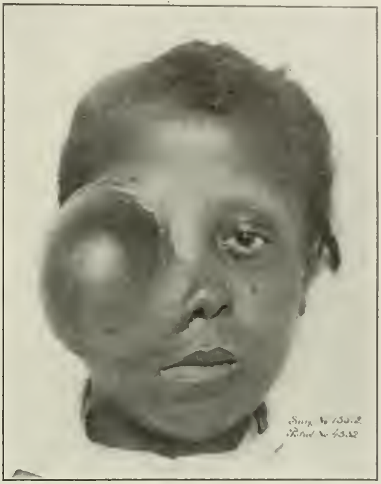

Fig. 584.—Pathol. No. 4332, Johns Hopkins Hospital, Halsted's Clinic. Dentigerous Cyst of Upper Jaw. Colored girl, aged nineteen; swelling thirteen years, parchment crepitation; teeth normal. Complete excision of upper jaw on diagnosis of sarcoma. Death from pulmonary abscess. (See Fig. 585.)

Dentigerous Cysts of the Upper Jaw.—At the onset the swelling produced by a cyst in the upper jaw may resemble a chronic hydrops of the antrum. If the cyst should become infected, the appearance presented will be that of an empyema of the antrum. In some cases the swelling may be very pronounced. (Fig. 584.) A specimen of a cyst of the upper jaw is shown in Fig. 585. The cyst may have more than one chamber, the partitions between the chambers being formed usually by a cartilaginous, fibrous membrane. (Fig. 586.)

The two cases referred to above emphasize the importance of making an exploratory incision. Had this been done, the extensive and wholly unnecessary operation would not have been performed.

In the case illustrated in Fig. 586 I found, in different places, remains of an epithelial lining.

Perthes (*op. cit.*) describes very fully the various forms of cysts which occur

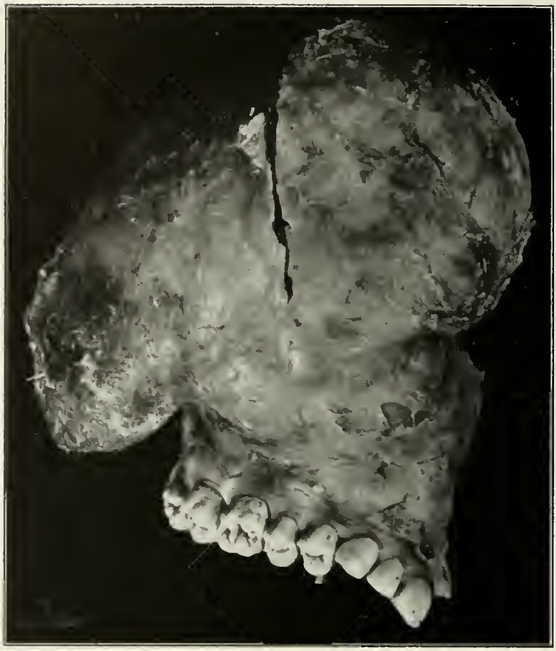

Fig. 585.—Pathol. No. 4332, Johns Hopkins Hospital. Dentigerous Cyst of Upper Jaw. Photograph of specimen removed from patient shown in Fig. 584.

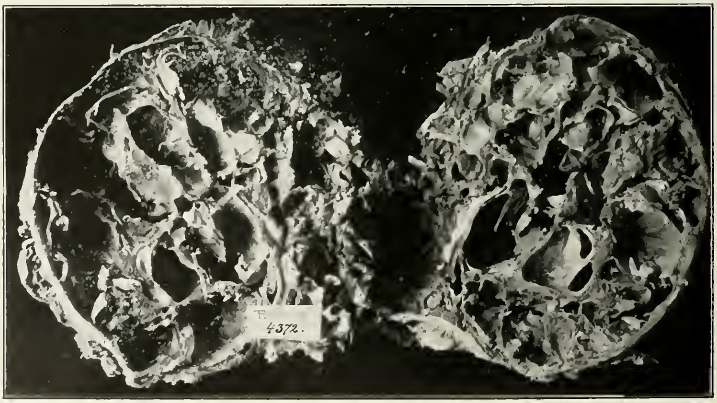

Fig. 586.—Pathol. No. 4372, Johns Hopkins Hospital, Halsted's Clinic. Multilocular Dentigerous Cyst of Upper Jaw. Photograph of specimen. White girl, aged eight years; duration of tumor not stated in the history. Complete excision of jaw on diagnosis of sarcoma. Death from shock.

in the region of the jaws. Partsch (*Centralbl. f. Chir.*, 1904, Vol. XXXI., p. 1329) contributes a very full article on the subject of dental-root cysts.

As an aid in diagnosis the *x*-ray is valuable. If there is a non-erupted tooth it will show in the plate, but this is not a positive sign of a dentigerous cyst. I have pictured such a tooth in a giant-cell sarcoma of the lower jaw. (See Fig. 570.)

Ethmoidal Cysts.—In view of their situation they will be described under Orbital Tumors.

C. Adamantine Epithelioma.—Adamantine epitheliomata must be differentiated from the strictly benign dentigerous cysts, on the one hand, and from the sarcomata on the other. In the dentigerous cyst incision and drainage are sufficient, but in the cystic and solid adamantine epithelioma the entire disease must be removed. I am confident, from my experience, that the operation need not be as extensive as that which is usually performed. All the cases of which I have records have remained well since operation. Recurrences will take place if the disease is not completely removed, but permanent cures have been accomplished even after the third operation for a local recurrence.

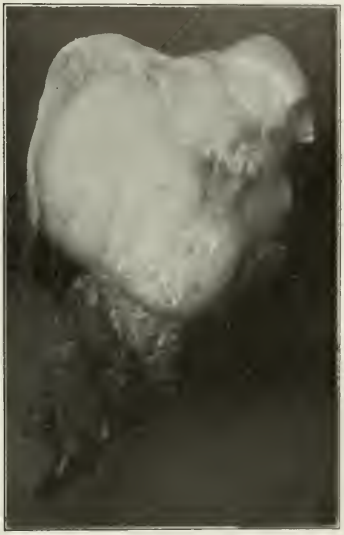

Fig. 587.—Pathol. No. 7348, Finney's Case. Adamantine Epithelioma of Alveolar Border. (× 3 diam.) Colored girl, aged seventeen years, tumor on the outer side of the jaw for ten months. Local excision; patient has remained permanently cured.

These tumors, composed of adamantine epithelium, may, in very rare instances, appear as tumors of the alveolar border. In the majority of cases, as the embryonic tooth residues are buried below the alveolar border, when they appear as a new-growth the tumor is covered with a bone capsule. This bone capsule is preserved even when the tumor has reached great size.

In the cases so far observed the age of onset has varied from fifteen to seventy-three years. In the older cases—those between fifty and seventy-three—the tumors have been situated on the alveolar border. The adamantine epithelioma, which appears as a tumor provided with a bone shell, originates as a rule somewhat later in life than the dentigerous cyst; but, as a matter of fact, the age of onset varies so greatly, except in carcinoma of the antrum, that one cannot allow this to have much influence in the diagnosis.

The length of life of the tumors belonging to this group has been found to vary from one to twenty-nine years. We have evidence, therefore, that this

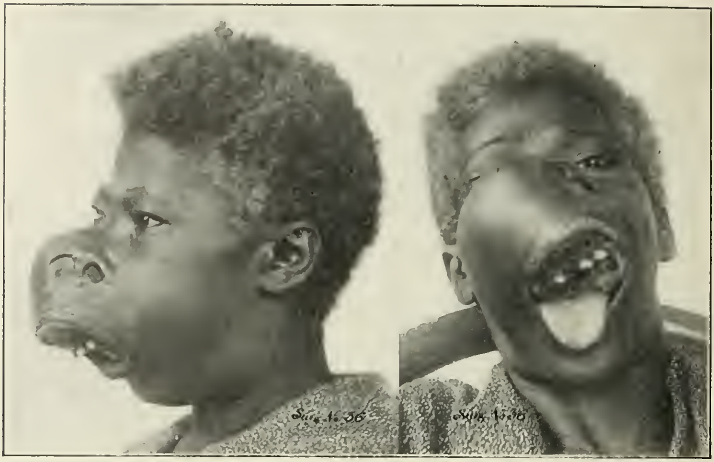

FIG. 588.—Surg. No. 36, Johns Hopkins Hospital, Halsted's Clinic. Central, Solid Adamantine Epithelioma of Both Halves of the Upper Jaw. Colored female, aged fifty-two years; tumor ten years.

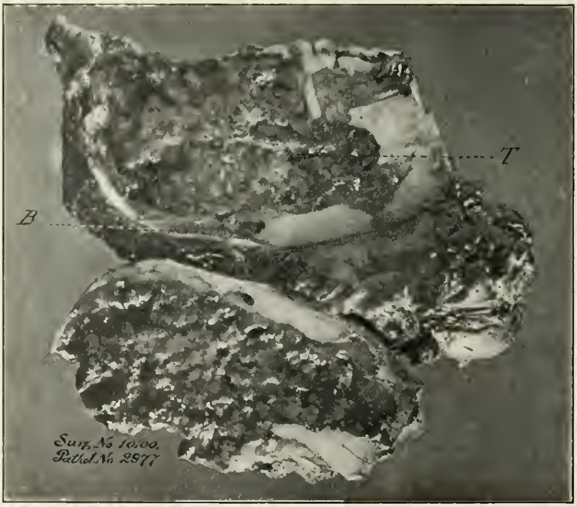

FIG. 589.—Pathol. No. 2977, Johns Hopkins Hospital, Cushing's Case. Solid Adamantine Epithelioma of the Lower Jaw. (Photograph of alcohol specimen.) Colored male, aged twenty years; tumor over five years in the body of the lower jaw, on the left side. Resection; patient has remained cured for nine years. *T*, Tumor; *B*, bone capsule.

tumor may be present for twenty-nine years and not produce metastasis. Although there have been some recurrences in the group of cases which I have seen, there has not been a single death from metastasis.

Adamantine Epithelioma of the Alveolar Border.—About one-third of the cases of adamantine epithelioma are cases in which the tumor occupies the alveolar border. The age of onset, as stated before, has usually been over fifty, but the case illustrated in Fig. 587 was that of a colored girl aged seventeen.

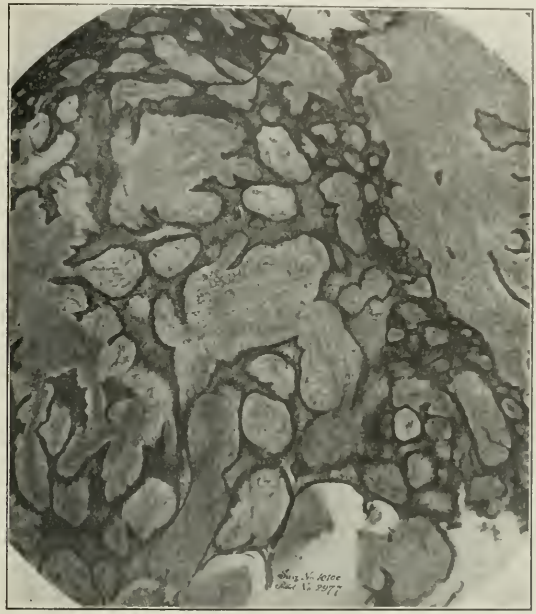

FIG. 590.—Pathol. No. 2977, Johns Hopkins Hospital. Photomicrograph (by Wright) of the Adamantine Epithelioma Shown in Fig. 589.

The appearance of the tumor is such that it has been mistaken in some cases for a malignant cancer, in others for a simple epulis. For example, it has been frequently mistaken for the very malignant carcinoma spinocellulare (squamous-cell malignant epithelioma), and, as a result, very extensive operations, with resection of the jaw and extirpation of the lymph nodes of the neck, have been performed. Then, again, it is often looked upon as an epulis of the fibromatous type, and, as a result of this mistaken diagnosis, it has been incompletely removed. The latter mistake is of course not very serious, but the unnecessary mutilation of the patient is certainly a matter of importance. In the recurrent cases a cure has often been effected by a secondary operation.

Fig. 587 illustrates the gross surface appearance of an adamantine epithelioma situated on the alveolar border. It was an encapsulated tumor covered with normal mucous membrane. From the white dots and lines, which may be clearly seen in the illustration, the tumor can be differentiated from the ordinary epulis, and from a mere inspection of this specimen the diagnosis of adamantine epithelioma was made. Later, this diagnosis was confirmed by the examination of sections under the microscope.

In the older patients the tumor may ulcerate, and then, unless the conditions be carefully studied, it may be mistaken for the very malignant carcinoma spinocellulare. I will discuss the differential diagnosis later, when I come to describe the primary carcinoma of the gum. One can easily be convinced, from this statement of the facts, that this differential diagnosis is one of great importance.

D. Solid Adamantine Epithelioma of the Jaw.—The solid tumors are much less frequent than the cystic. Fig. 588 illustrates the huge size that one of these tumors of the upper jaw may reach. The length of life of this tumor—ten years—would exclude a carcinoma or a sarcoma, and the diagnosis would simply rest between a benign dentigerous cyst and the adamantine epithelioma. Fig. 589 pictures the appearance of the solid tumor. It differs from the other form only in the absence of minute or larger cysts. In the gross one can see a fibrous stroma in the meshes of which there is a coarsely granular, whitish, somewhat friable tissue. Under the microscope it is seen that this tumor, which appears to be solid, possesses in reality a tendency to the formation of minute cysts. (Fig. 590.)

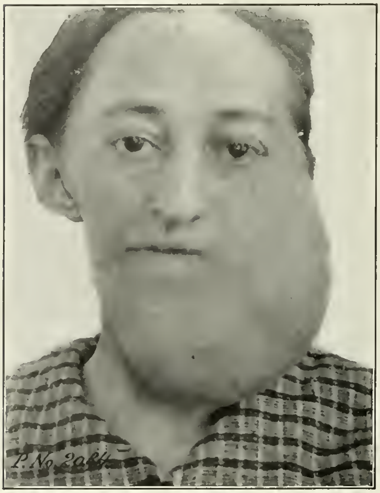

Fig. 591. Pathol. No. 2084, Johns Hopkins Hospital, Halsted's Clinic. Central Cystic Adamantine Epithelioma of the Lower Jaw. White female, aged thirty-seven years; tumor twenty years; resection. Well ten years after operation. (See Fig. 592.)

E. Cystic Adamantine Epithelioma of the Jaw.—This tumor is more frequent than the dentigerous cyst and the most common form of adamantine epithelioma. With few exceptions it involves the lower jaw. It appears as a tumor with a distinct bone capsule which gives parchment-like crepitation. Its length of life may be considerable—twenty years—and it may reach great size. The tumor shown in Fig. 591, although quite large, is by no means the largest I have seen. The patient in this case was first given a hopeless prognosis in the belief that the tumor was an inoperable sarcoma. The long period during which it had existed—twenty years—should have excluded a sarcoma or a carcinoma. The excellent result obtained in this case by a complete excision emphasizes the relative benignity of this epithelial tumor,—a fact which has not always been recognized heretofore in current literature. (Fig. 592.)

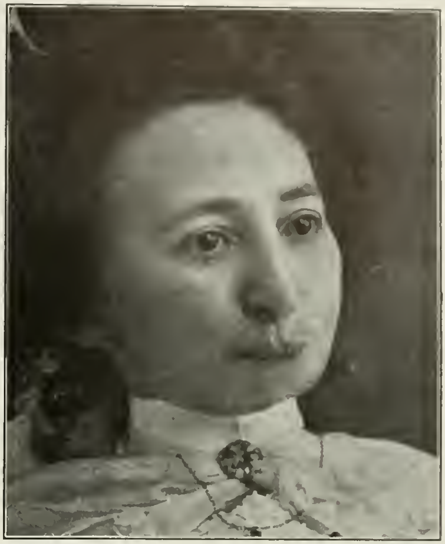
Fig. 592.—Pathol. No. 2084, Johns Hopkins Hospital. Halsted's Clinic. Central Cystic Adamantine Epithelioma of Lower Jaw. White female, aged thirty-seven years. Tumor twenty years. Resection. Photograph of result ten years after operation.

Under simple inspection the bony capsule appears to vary appreciably in thickness. (Fig. 593.) In certain places it seems to have disappeared entirely and to have been replaced by a fibrous capsule. The tumor itself is composed of smooth cysts of various sizes which contain either a serous or a cloudy fluid or a fluid mingled with white granular material. The difference in the character of this fluid depends upon the lining of the cyst. When the fluid is clear it will be found that the epi-

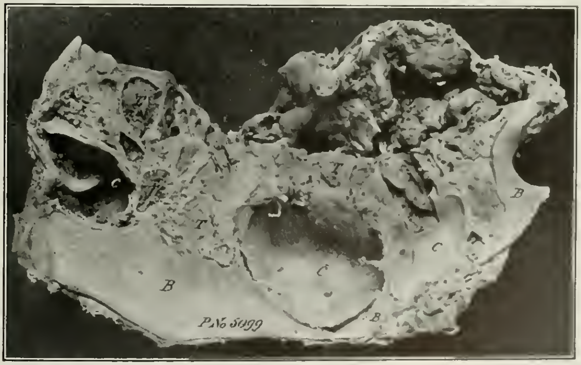

Fig. 593.—Pathol. No. 5099, Johns Hopkins Hospital, Halsted's Clinic. (Photograph by Schapiro.) Central Cystic Adamantine Epithelioma of Lower Jaw. Colored male, aged twenty-eight years; tumor ten years. Resection; patient has remained cured five years. *C*, *C*, Cysts; *B*, *B*, bone capsule; *T*, epithelial tumor formation.

thelial lining has entirely disappeared, while in the other conditions the lining will be found to be present. Besides these cysts there are areas of tumor substance which are separated, one from another, by fibrous tissue, and which resemble in character the tissue described under Fig. 589. These areas may be solid or they may contain minute cysts, which latter condition lends to the structure as a whole a spongy appearance. By good fortune all of these different appearances are present in Fig. 592. This one illustration, therefore, practically covers all the possible variations of this remarkable neoplasm.

Literature.—Pincus, in Archiv f. klin. Chir., 1904, vol. lxxii., p. 995; Matsuoka, in Deutsche Zeitschr. f. Chir., 1904, vol. lxxiv., p. 594; Bloodgood, in Jour. Amer. Med. Assoc., October 15th, 1904; and Steensland, in Jour. of Experimental Med., 1905, vol. vi., p. 377.

IV. Primary Carcinoma of the Mucous Membrane of the Mouth and Gum, with Secondary Involvement of the Jaws.

Primary epithelial tumors of the epidermis of the gum surrounding the teeth, or covering the alveolar border of the upper and lower jaws, are much less frequent than similar tumors arising from the lower lip or tongue, but they are equally as frequent as primary tumors of the cheek. So far as my observation goes, practically all the epithelial tumors which spring from mucous membrane, may arise from the gum. In the majority of cases the tumor, whether benign or malignant, originates from the socket from which a tooth has been extracted. Primary epithelial tumors of the gum are rarely observed in persons whose teeth are perfectly normal.

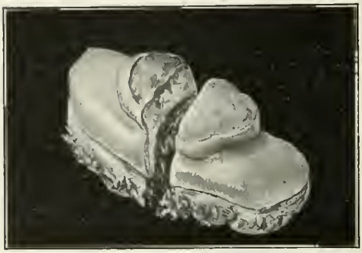

Fig. 594.—Pathol. No. 6327, Author's Case. Carcinomatous Ulcer of Gum of Upper Jaw, with Metastasis to Lymph Nodes of Neck. White male, aged sixty years; ulcer six months. Pigment due to use of silver nitrate.

When there have been repeated slight traumatisms from the wearing of a plate or from the presence of a band about the teeth, there may develop a *benign hypertrophy* of the epidermis, resembling an ordinary corn. This should not be mistaken for a malignant tumor. There is neither ulceration nor induration. Under the microscope one finds simple thickening of the epidermis. The relation of the basal cells of the epidermis to the connective tissue is preserved.

The Papilloma.—The papilloma of the gum may be benign or malignant. Ulceration, to a slight extent, is not a positive sign of malignancy. As a rule, these papillomatous growths involve considerable surface areas. (Plate XXXIX, Fig. 3.)

Unless the papilloma has the distinct appearance of a malignant tumor, it will be found wise, before one operates, to remove a piece of the growth for examination, because the malignant papilloma should be subjected to a much more extensive local removal than the benign, and, in addition, the related lymph nodes should be excised.

The Basal-Cell Epithelioma.—The basal-cell epithelioma, which may appear as an ulcer (rodent ulcer) or as a fungus, is a very rare tumor of the mucous membrane anywhere, and especially of the mucous membrane of the gum. As these tumors are relatively benign and easily curable by local excision, one should bear this fact in mind. If the diagnosis cannot be made from the appearance of the ulcer or the fungus, a piece should be excised for microscopic study.

The *malignant spinous-cell epithelioma of the gums (epithelioma spinocellulare malignum)* is not more frequent than the benign or less malignant tumors just described. I emphasize this because for the more malignant tumor such a radical operation is demanded that in every case, if the lesion on the gum does not distinctly appear to be malignant, a piece should be excised for diagnosis before the extensive operation is performed.

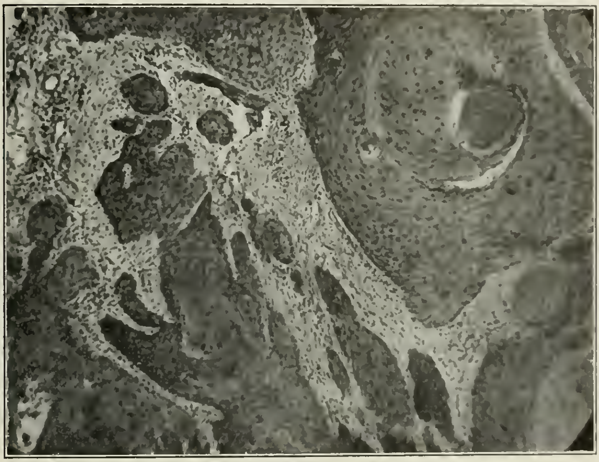

Fig. 595.—Pathol. No. 2773, Author's Case. Photomicrograph of Carcinoma Spinocellulare. Fungous tumor of gum of lower jaw at symphysis, extending to floor of mouth toward tongue. White male, aged sixty-one years; tumor seven months; patient remained cured seven years after complete operation.

Similar to malignant epithelial tumors of the mucous membrane elsewhere the spinous-cell tumor appears as an ulcer or as a fungus. The ulcer is the more common lesion. In both forms the disease is characterized by a marked induration beyond the ulcer or the fungus,—a condition which is not present in the basal-cell tumor nor in the papilloma. In my experience this tumor is not difficult to diagnose. Fig. 594 shows well the picture of the cancerous ulcers of the gum; Fig. 596, the tissue removed; and Fig. 597, the result. The slight elevation of mucous membrane at the edge of the ulcer is quite characteristic. In this case the induration about the ulcer was sufficient evidence

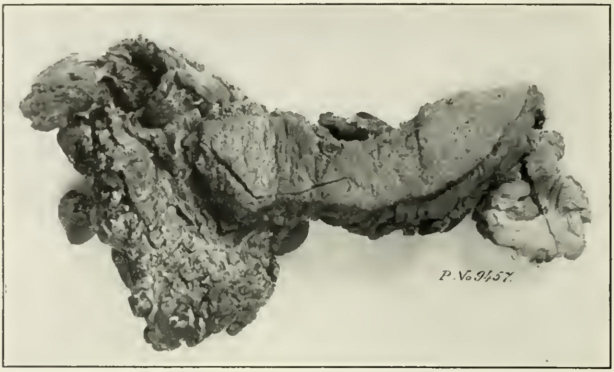

Fig. 596.—Pathol. No. 9457, Author's Case. Photograph (by Schapiro) of Alcohol Specimen Showing Tissues Removed in a Carcinoma of the Gum of the Upper Jaw. (See Fig. 597.)

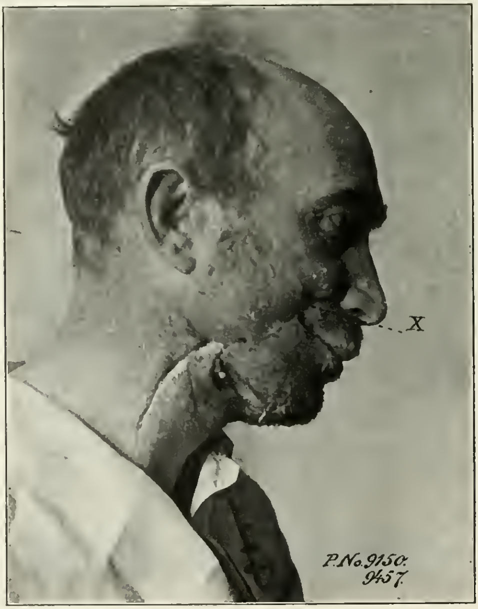

Fig. 597. Pathol. No. 9457, Author's Case. Photograph (by Schapiro) of Patient Three Weeks after Operation, at which specimen shown in Fig. 596 was removed. X, Position of tumor on gum.

upon which to base the diagnosis. The wound left in this instance after the extraction of a tooth had never entirely healed: a small sinus persisted. The development of a malignant epithelial tumor in a sinus tract has been observed so frequently that there seems no doubt as to the possibility of its being the etiological factor.

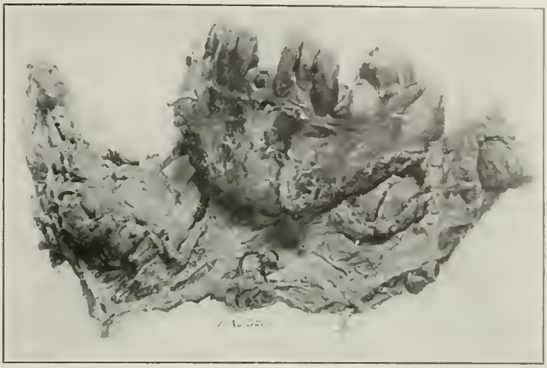

Fig. 598.—Pathol. No. 3216, Johns Hopkins Hospital. Carcinoma of Floor of Mouth between Tongue and Symphysis of the Jaw. Resection of lower jaw *en bloc* as far as the second molar, resection of the lymph nodes of the neck on both sides, also *en bloc*.

Fig. 595 is a photomicrograph of a carcinoma spinocellulare. In this instance the symphysis of the lower jaw, the tumor, the floor of the mouth, and the affected lymph nodes of the neck were removed in one mass. Fig. 598 gives a fair idea of the general appearance of this mass. Farther on, when I come to discuss the operative technique, I will describe the methods of procedure.

V. Carcinoma of some other Mucous Membrane than that of the Gum, with Secondary Involvement of the Upper or the Lower Jaw.

In all forms of carcinoma, primary or metastatic, in the region of the upper or the lower jaw, resection of the upper or lower jaw may be required. On the one hand, this operation is necessary, not because the bone is involved, but because its removal allows the surgeon to give the primary or the metastatic growth a wider berth. This resection may be temporary or permanent. On the other hand, the operation may be necessary because the bone is actually involved in the growth. Among 110 primary epitheliomas of the lip excision of the lower jaw was indicated in 9 cases—about eight per cent. It is very interesting to note that in 7 of these cases the tumor was a definite recurrence after an incomplete primary operation. Among these 9 cases there was only one instance of a well-established cure, and in studying the facts of this case I became convinced that the tumor must have been an adamantine epithelioma, arising rather in the mucous membrane between the lip and the gum than in the lip itself. These figures show that, in cases of epithelioma of the lower lip, with involvement of the bone, it has not been permissible, up to the present time, to give anything but a hopelessly unfavorable prognosis.

In carcinoma of the cheek, in which the tumor has arisen in the epidermis, the adjacent jaw has been involved in twenty-five per cent of the cases (10 cases out of 43). The bone is, therefore, more frequently involved in cancer of the cheek than in cancer of the lower lip. The upper jaw is the part usually affected, and in seventy-five per cent of the cases a cure has been obtained. This favorable result, however, is due to the fact that the majority of malignant epitheliomas arising in the skin of the face belong to the less malignant basal-cell variety. Up to the present time I do not know of a single cure in which the tumor was a carcinoma spinocellulare. The decision when to remove a piece of the upper or the lower jaw in a carcinoma of the face depends upon the local growth of the tumor. If there is loose areolar tissue between the tumor and the periosteum, and if the latter may be stripped off as from normal bone, the periosteum alone should be removed; but when the tumor infiltrates the periosteum, remove the bone, without regard to its condition.

Primary carcinoma of the skin of the chin is relatively a rare lesion. All the cases which I have observed have been basal-cell tumors, and in not a single instance did the related lymph nodes become involved; but in three out of the four cases, it was found necessary, on account of the infiltration of the rodent ulcer, to excise bone at the symphysis. In the only one of this group of cases in which an attempt was made to learn the subsequent history, it was found that the patient had remained well since the operation.

The results which follow when a carcinoma of the lower lip involves the adjacent bone and those which follow when a carcinoma of the skin of the face and chin involve the bone, show rather plainly that, in respect of malignancy, there is a great difference between Krompecher's basal-cell epithelioma (formerly called rodent ulcer) and carcinoma spinocellulare, better known as squamous-cell epithelioma.

The relation of primary carcinoma of the eyelids and orbit, and also of the nose, to involvement of the upper jaw will be considered under Orbital Tumors.

The prognosis of primary carcinoma spinocellulare of the mucous membrane of the cheek, with secondary involvement of the upper or the lower jaw, is very bad,—in my experience, hopeless.

Primary carcinoma of the tonsil, as well as of the hard and the soft palates, will be considered in the sections devoted to naso-pharyngeal tumors and to tumors of the hard and the soft palates.

VI. Orbital Tumors.

According to my own experience and also according to the statements made by Koehl* orbital or retrobulbar tumors are uncommon. The earliest symptom is usually unilateral exophthalmos. In the presence of this symptom one must bear in mind the possibility of an arterio-venous aneurysm which produces a pulsating exophthalmos, of Graves' disease in which unilateral exophthalmos is very rare and which is always associated with some other of the characteristic eye symptoms, as well as with such other thyreotoxic symptoms as tachycardia, etc. When the exophthalmos does not pulsate, and when the patient has no other signs of hyperthyroidism, look for a retrobulbar tumor. In the majority of cases this tumor is palpable.

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* Beitraege zur klin. Chir., 1906, vol. xlix., p. 90.

In the orbital region I have observed two cases of cysts of the ethmoid, one gumma, three sarcomas, and three carcinomas.

Cysts of the Ethmoid Sinuses.—The two cases which came under my observation have remained well since I curetted the cyst. In one patient, aged thirty-six, the first symptoms observed were: double vision, which continued for five months; unilateral exophthalmos; and a swelling in the angle between the nose and the eyebrow. At this spot one could palpate the shell of bone which gave parchment crepitation. When the exploratory incision was made there were found, first, a well-defined shell of bone, then a connective-tissue lining, and last of all, the contents of the cyst, consisting of a viscid yellow material. The exploration of the deeper portions of the cyst showed that it was composed of many cavities. Upon the completion of the curetting it was found necessary to pack the wound. The sinus did not heal for six weeks. Since the operation, which was performed six years ago, the patient has had no recurrence of the trouble. My colleague, Cushing, operated upon a similar case in which the symptoms (tumor, exophthalmos) had been present for three years. It is interesting to note that in this case the cyst of the ethmoid sinuses apparently followed the removal of the polypus from the right naris.

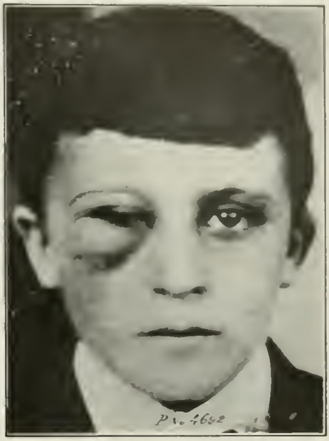

Fig. 599.—Pathol. No. 1692, Author's Case. Mixed Myxosarcoma of Orbit; contained spindle, round, and giant cells. White boy, aged thirteen years; exophthalmos two months. Well, six years after operation. (See Fig. 601.)

Clinically, it might be difficult to differentiate such a tumor from one of a malignant nature, but at the exploratory incision the innocent character of the cyst is at once apparent.

Richard H. Johnston* reports a case of exophthalmos which was associated with disease of the ethmoidal and frontal sinuses, and in which recovery followed drainage. In this instance the exophthalmos was of rapid formation and was associated with choked disk, but there was no œdema of the eyelid or eyeball, nor any signs of an inflammatory process. Yet, when the nares were examined, pus escaped from both the frontal and the ethmoidal sinuses, with the rapid disappearance of the ocular symptoms.

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*Ophthalmic Record, June, 1905.

Arnold Knapp (*Archives of Ophthalmology*, 1903, Vol. XXXII., No. 3) reports a similar case in which the symptoms were of longer duration. This patient died with meningitis after drainage of the ethmoidal sinuses through an external incision.

Orbital Abscess.—This is a rare complication. Clinically, it is not difficult to recognize on account of the definite inflammatory symptoms present on the eyelids and eyeball. Orbital abscess may be secondary to infections of the ethmoidal or frontal sinuses, as in the case of Oliver and Wood (*American Jour. of Med. Sciences*, July, 1902, Vol. CXXIV., p. 92). The probabilities are that in Johnston's and Knapp's cases just mentioned an orbital abscess would have developed later. Orbital abscess secondary to antrum infection is very rare.

General Remarks with Regard to Orbital Tumors.—There is one point which I wish to emphasize, viz., that the benign and less malignant tumors of the orbit can frequently be removed without injury to the eye and without great mutilation. On the other hand, the tumors which require a more radical excision are rarely permanently cured. If the surgeon is in doubt in regard to the pathology of the tumor, he should act conservatively.

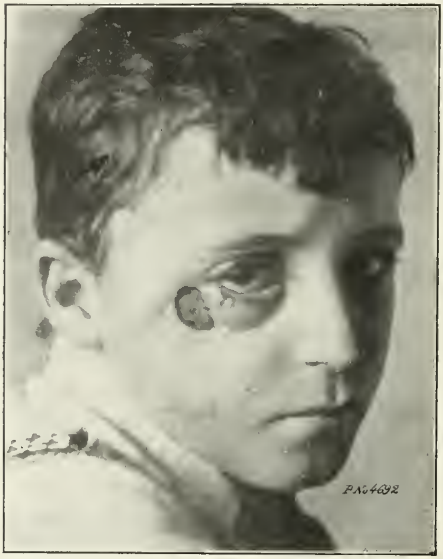

Fig. 600.—Pathol. No. 4692. Author's Case. Sarcoma of Orbit. Photograph ten days after operation. Fig. 599 shows patient before operation, and Fig. 601 the late result.

Fig. 599 shows the unilateral exophthalmos and projecting tumor in the lower and outer quadrant of the orbit. The patient was a male, aged thirteen, and the exophthalmos and the tumor had been observed for only about two months. An exploratory incision had been made before I saw the patient. At the operation, in March, 1903, I found that the tumor was somewhat encapsulated and could be dissected without injury to the eye, but it was curetted from the side of the antrum cavity, into which it had grown after destroying the bony floor of the orbit. The removal was accomplished without mutilation, as shown in Fig. 600. Six years have elapsed since the operation, and up to the present time there has been no recurrence.

In a second case (Fig. 602) which I saw at about the same time, the pathology of the removed tumor was that of a most malignant round-cell sarcoma of the lymphoid type. Death took place from metastasis. It is interesting to note that in this case exophthalmos was present for several weeks before the tumor in the upper and inner quadrant of the orbit was observed.

Schuchardt* reports an osteoma of the upper orbital wall which he successfully removed by Kroenlein's osteoplastic method, without injury to the eye and without mutilation. The symptoms were characteristic of a retrobulbar tumor, and, although the growth was of a strictly benign character, these symptoms did not differ from those of a malignant tumor. There were, first, diplopia, then unilateral exophthalmos, and finally tumor.

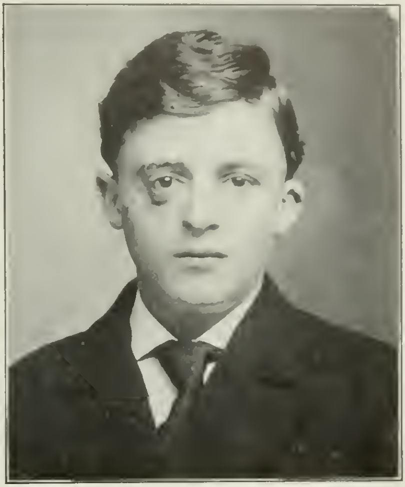

Fig. 601.—Pathol. No. 4692. Author's Case. Photograph of Patient Shown in Fig. 599; six years after operation.

Koehl's experience† gives us further evidence of the importance, in maxillary and orbital tumors, of making a diagnosis before resorting to a mutilating operation, and, if there be any doubt, of erring on the conservative side. In his second case, that of a woman of sixty-five, there were exophthalmos and a palpable tumor which had existed for two years, and, as there were congenital pigmented moles on the cheek, a diagnosis of melanotic sarcoma was made. On the strength of this diagnosis a more extensive operation was performed. The tumor proved to be a benign fibro-angioma. In Koehl's first case the relatively benign fibrosarcoma of six years' duration was removed (as is usually done in all such cases) by Kroenlein's osteoplastic method, with relief of the exophthalmos and restoration of vision.

The melanotic variety of sarcoma occurs not infrequently as an orbital tumor. The prognosis is hopelessly bad. In a case of which I have notes exophthalmos, hemorrhagic retinitis, and choked disk were the only symptoms which were observed during a period of about eight months. When the eyeball was removed the retrobulbar pigmented tumor was exposed. It is a question whether it is worth while to subject such patients to a mutilating operation.

The psammoma, already mentioned as a possible antrum tumor, is a not uncommon orbital tumor. Fig. 603 is a photomicrograph of this interesting sarcoma, which is relatively benign.

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* Deutsche Zeitschr. f. Chir., 1900, vol. liv., p. 371.

† Beitraege z. klin. Chir., 1906, vol. xlix., p. 90.

Carcinoma of the Orbit.—Carcinoma of the eyelids may secondarily involve the orbit, but malignant epithelial tumors of the lachrymal gland begin as primary orbital growths. Among thirty-one primary tumors of the eyelid all but three were of the basal-cell variety and might readily have been cured by a local excision if the operation had been instituted early in the disease. Left alone, the basal-cell epithelioma becomes a rodent ulcer and slowly involves the conjunctiva and eyeball. When this has taken place enucleation of the eye is indicated, and cures have been accomplished at this stage. When the deeper retrobulbar tissue is involved the prognosis is unconditionally bad.

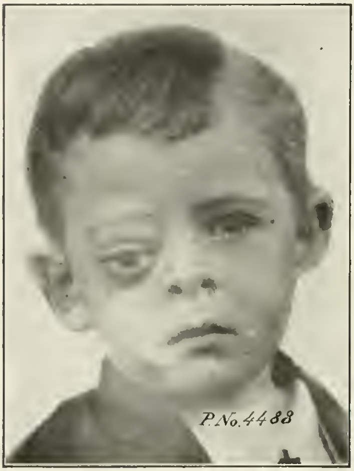

Fig. 602.—Pathol. No. 4488. Author's Case. Small Round-cell Sarcoma of Orbit, with Exophthalmos. Boy aged five years; symptoms six weeks. Death six weeks after operation, from general metastasis.

Fig. 604 illustrates the clinical appearance of a very extensive carcinoma, probably primary in the lachrymal gland. There were: unilateral exophthalmos, loss of sight, great œdema of the eyelid and eyeball, no dilatation of the veins, no pulsation, and no bruit. On palpation a tense tumor could be felt behind the orbit. An attempt at operation demonstrated that the lesion was inoperable.

On Plate XXXVIII, Fig. 3, *a* and *b*, there are shown the capsule and a section of a primary adenocarcinoma of the lachrymal gland. This case is of greater interest, because the tumor was originally benign and for twelve years gave no symptoms. During this period it should have been removed, because it could then be seen and felt in the upper and outer margin of the orbit. As the tumor grew, there developed, about two and a half years before the operation, double vision and exophthalmos. Recently (*i.e.*, within the past month) acute inflammatory symptoms manifested themselves and an abscess formed. This was first drained, and then the tumor was removed, but the infiltration of the orbital tissue was too extensive to give any hope of a radical excision.

Fig. 605 is a photograph taken, after the operation, to illustrate an attempt at complete eradication of all the tissues within the orbital cavity, in a case of carcinoma arising in the lachrymal gland. This experience and that of many others whose published cases may be found in the literature of the subject furnish ample evidence that the carcinomata and the more malignant sarcomas may not be cured even by the most extensive and mutilating operation. On the other hand, it is an established fact that the benign and less malignant forms of sarcoma have remained free from recurrence even after a conservative operation, one in which the eyeball is preserved. These facts should be borne in mind by every surgeon in attacking orbital tumors. The retrobulbar tumors can be exposed by Kroenlein's osteoplastic method without injury to the eyeball.

VII. Intranasal Tumors.

My experience has been mainly with cases of carcinoma of the upper jaw, apparently arising in a nasal polypus of the adenomatous type. In this group of cases not a single cure has resulted from the most extensive operations, nor have I been able to ascertain any favorable results in the literature. The same has been true of the malignant epithelial tumors arising from the mucous membrane of some parts of the nose.

Through the courtesy of Dr. Rosenheim I have been able to examine a number of cases of the various types of benign intranasal growths. I have also enjoyed the privilege of consulting a monograph which was published in 1907 by Harmer and Glas * on the malignant tumors of the inner nose. This monograph contains a résumé of the literature of the subject. With this evidence before me I feel justified in repeating the statement made in 1903,† viz., that the cases of carcinoma and sarcoma of the nose which up to the present time have been referred to the general surgeon for treatment, have not been cured. The solution of the problem therefore rests in the hands of the rhinologist. He should subject every intranasal growth to a careful microscopic examination. It is only in this way that he will learn to distinguish the malignant from the

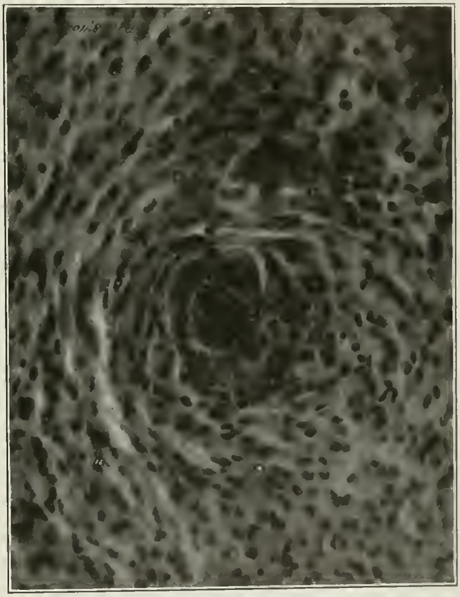

Fig. 603.—Pathol. No. 8710. Case of Dr William H Welch. Perithelioma of Dural Sheath of Optic Nerve. Psammoma bodies not calcified.

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* Deutsche Zeitschr. f. Chir., 1907, vol lxxxix, p. 433.

† Monograph on Tumors of the Jaw, as yet unpublished.

benign tumors and that he will be able to refer cases of the former category to the surgeon for operation at an earlier period than has hitherto seemed practicable. What the results will be, it is impossible to state; at least, they cannot be worse than they are now.

As a matter of fact, sarcoma and carcinoma are relatively rare lesions of the nasal cavities. According to Kuemmel (quoted by Harmer and Glas) they occur approximately in the proportion of one malignant tumor to 23,000 cases of nose and throat disease.

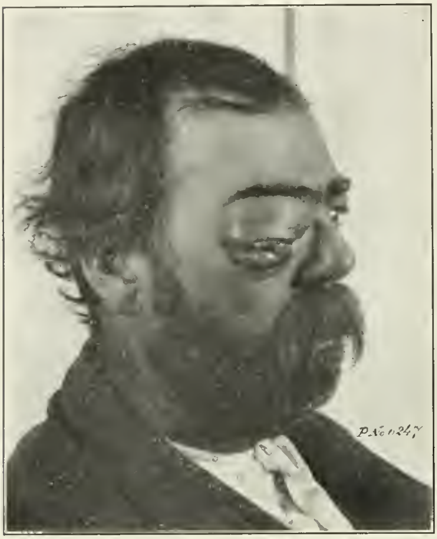

FIG. 604.—Pathol. No. 6247, Johns Hopkins Hospital, Halsted's Clinic. Adenocarcinoma of the Lachrymal Gland, Inoperable. White male, aged forty-one years. Tumor one year.

Relation of Malignant Tumors to Nasal Polypi.—Billroth in 1855 was of the opinion that there was no definite proof that benign nasal polypi underwent a malignant degeneration. Harmer and Glas apparently agree with Billroth, but they call attention to the frequent coincidence of malignant tumors and benign nasal polypi. This relation may be expressed in four ways:—

(1) The polypi may be the product of a simple chronic inflammation, and then carcinoma may develop accidentally at some later date.

(2) The polypi may develop secondarily, as the result of a chronic catarrh of the mucous membrane in the vicinity of the malignant tumor.

(3) There may be malignant degeneration of a benign polypus.

(4) The malignant tumor in its growth may assume in places a polypoid form.

It is my opinion that all of these four conditions are possible;—but the mere academic discussion of the subject is at this time of no practical value. It seems wiser, with our present knowledge, to remove all intranasal polypoid growths properly, to subject them to microscopic examination, and then, when a malignant histological picture is found, to subject the patient to a more extensive surgical intervention.

In the cases which I have observed there has been a history of polypoid growths running back over a period of from one to ten years. Many of these patients had been subjected to repeated operations, but in only one instance had a microscopic examination of the tissue removed been made. In the other cases the patients had been referred to a general surgeon only after repeated recurrences of the polypoid growths, and, in some instances, only after definite evidence of involvement of the antrum or orbital cavity had manifested itself.

Benign Nasal Polypi.—These vary in size, position, and character, some being pedunculated and others sessile. They all have a covering of mucous membrane. In the majority of cases the chief tissue of the polypoid growth is myxomatous. Frequently the tissue is very vascular—angiomyxoma. In some cases hypertrophied glands are found throughout the tumor—adenomyxoma. Now and then, in the smaller polypoid growths, there may be more fibrous tissue—fibromyxoma.

If the mucous membrane which covers the polypus receives an injury, the inflammatory reaction excited by the infection which enters through this portal may cause the growth of a cellular granulation tissue which is scarcely distinguishable, except by an expert examiner, from sarcoma. The point which I wish to emphasize is, that for the proper appreciation of intranasal growths the rhinologist should in every instance study the removed tissue microscopically and should keep track of his patients. This is emphasized by Rosenheim * and also by Packard.†

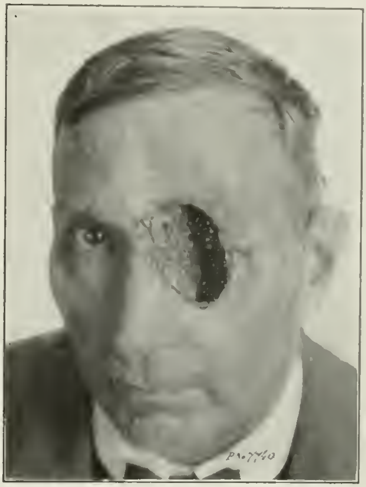

FIG. 605.—Pathol. No. 7740. Author's Case. Photograph of Patient after Operation; to illustrate an attempt at the complete removal of all the tissues within the orbital cavity for carcinoma.

From my personal experience and from a study of the literature, I feel convinced that the early cases of carcinoma and sarcoma can easily be recognized from the microscopic picture. I would emphatically advise, however, that, in all cases of intranasal polypi in which there is a suspicion of malignancy, the patient be given the benefit of the doubt and that the disease be treated as if it were of an innocent nature. *In view of the present hopeless prognosis in cases of intranasal carcinoma and sarcoma, no patient should be subjected to the radical and mutilating operation ordinarily employed for the removal of a malignant tumor unless the diagnosis is absolutely certain.*

Carcinoma.—The intranasal carcinomas which do not arise in, or which are not associated with, polypoid growths, resemble in their gross and microscopic pathology malignant epithelial tumors of the mucous membrane in other parts of the body. They appear, first, either as small ulcers or as fungi, and they give rise to nasal discharge, frequently hemorrhagic. As a rule, there is no obstruction in the early stage of the disease. With proper illumination the educated eye should be able to distinguish the carcinomatous ulcer from the simple. In all cases that are suspicious a piece of the tissue should be removed for diagnosis.

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* Johns Hopkins Hospital Bulletin, June, 1906, vol. xvii., p. 181.

† American Journal of Medical Sciences, November, 1903.

The position occupied by the malignant epithelioma varies. It may be present on the septum or on the lateral nasal wall, near the antrum opening. A primary origin in the frontal sinus is very rare. Moure classifies carcinomata as to whether they are present in the lower, the median, or the upper portion of the nasal cavity.

I am convinced that there is less hope, even if the nature of the tumor is recognized early, for a primary carcinoma of the nasal mucous membrane than for one originating in a nasal polypus. The symptoms are often obscure. On account of the position of the growth it is apt to spread rapidly to the accessory sinuses or to the orbital cavity. Infiltration through the hard and soft palates into the oral cavity is an uncommon occurrence and is observed only in the later stages.

After a carcinoma has been present for a short time it is very apt to be complicated with a purulent infection of the accessory sinuses, and quite frequently the inflammatory symptoms may be the first to attract attention; they mask the malignant disease. For this reason, in all cases in which the antrum or sinuses are opened for the relief of infection, a microscopic study should be made of the tissue removed. In about fifty per cent of the cases of primary intranasal carcinoma which I have seen, the diagnosis was made in the laboratory, after a microscopic examination of the tissues removed when the abscess in the antrum was exposed for drainage.

There may be more hope for malignant epithelial tumors which are situated in the lower portion of the nose. They give rise to earlier symptoms and are more readily exposed to view.

The lymph which comes from the parts bordering upon the nasal cavity and from the accessory sinuses flows in a backward direction and mingles with that contained in the subarachnoid and subdural spaces and the retropharyngeal area in front of the cervical vertebræ.

Involvement of the submaxillary and submental lymph nodes, in primary intranasal carcinoma, is uncommon, and the establishment of such lymphatic involvement is a contra-indication to anything except a palliative operation.

In intranasal carcinoma the only hope is for early intervention before metastasis has taken place.

Sarcoma.—In the majority of cases the sarcoma either appears in the form of a simple nasal polypoid growth or occurs as a secondary change in a benign myxoma.

In other forms of sarcoma one must differentiate the disease from tuberculosis and from syphilis. Tuberculosis should be recognized from the microscopic appearances. To distinguish between a syphilitic inflammation and a sarcoma is often difficult. In view of the hopeless prognosis for sarcoma, I should repeat the advice offered for carcinoma: If there is any doubt, treat the patient for the benign lesion.

Cysts of the Middle Turbinated Bone.—Jonathan Wright * and Shambaugh † have described cysts of the middle turbinated body the pathology of which is similar to the ethmoid cysts which I have described. They are benign lesions and should be treated conservatively.

VIII. Nasopharyngeal Tumors.

The same problems present themselves in the nasopharynx as in the nasal cavity proper. I believe that, in cases of carcinoma or sarcoma of the nasopharynx, of the more malignant type, operative treatment offers little hope. But there are, in the nasopharynx as in the nose, strictly benign tumors, or sarcomas of a very low grade of malignancy, which are curable after an operative removal which amounts to little more than enucleation.

My personal experience with tumors of the nasopharynx is limited. Fig. 605 illustrates a nasopharyngeal growth which has filled and projects from the left nasal passage, has entered the left orbit sufficiently to produce slight exophthalmos, and has involved the left antrum, thereby producing slight swelling of the cheek. There is, however, no recognizable swelling in the temporal fossa. Such tumors may be strictly benign and operable. This case unfortunately proved to be malignant (round-cell sarcoma); it had involved the base of the skull.

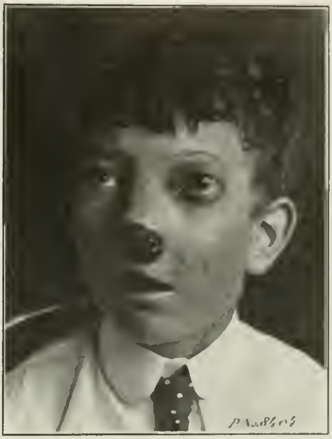

Fig. 606. Pathol. No. 8401. Author's Case Photograph of Patient with Nasopharyngeal Tumor. Note left exophthalmos, bulging of left naris with protruding growth, mouth-breathing, and slight prominence of cheek and temporal fossa. The tumor proved to be an inoperable sarcoma.

The most recent and complete contribution on this subject is that published by Pincus,‡ from observations made in von Bergmann's clinic. This monograph is based on eighteen cases and gives a review of the literature. Custodis § describes the various operative procedures for the cure of nasopharyngeal tumors, while Hertle ∥ and Payr ¶ describe Kocher's osteoplastic resection of both halves of the upper jaw—a temporary procedure carried out for the purpose of exposing the nasopharynx. Habs * reports an extirpation of a benign nasopharyngeal tumor successfully effected by the aid of a temporary resection of the hard palate.

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* American Journal of Medical Sciences, May, 1907.

† Annals of Surgery, 1902, xxxvi., p. 109.

‡ Archiv f. klin. Chir., 1907, vol. lxxxii., p. 110.

§ Beitraege z. klin. Chir., 1905, vol. xlvii., p. 37.

∥ Archiv f. klin. Chir., 1904, vol. lxxiii., p. 75.

¶ Archiv f. klin. Chir., 1903, vol. lxxii., p. 284.

Anatomical Considerations.—The pharynx is a peculiarly shaped space, the upper arch of which is formed by the base of the skull. This upper arch is called the fornix, and this portion of the pharynx communicates with the nasal cavity—the nasopharynx. Beneath the mucous membrane of the pharynx there is a great deal of lymphoid tissue, hypertrophy of which tissue gives rise to tumors called adenoids. Beyond this there is a distinct fibrous capsule which contains areas of cartilage, lesions of which tissue constitute the common nasopharyngeal fibroids.

Adenoids.—These lesions have been discussed elsewhere. (See Dr. Knight's article in Vol. V.) They are not difficult to recognize, and their operative removal is simple. This is the most common lesion in the nasopharynx of children. In adults, however, a growth in the nasopharynx which has the appearance of adenoids should be regarded with suspicion, and a piece should be examined under the microscope before any operative intervention is instituted.

Fibroids.—This is almost a special tumor of the nasopharynx. Pathologically, it is a lesion on the border line between a benign and a malignant connective-tissue tumor. The fibroids of the nasopharynx, if not completely removed, recur a number of times after operation. They resemble, therefore, the keloid and the desmoid tumor of the abdominal wall, or the angioma.

Histologically, the fibroids of the nasopharynx are very vascular. It is this feature which makes operative intervention serious.

The fibroid tumors arise from the connective tissue between the mucous membrane of the pharynx and the base of the skull. There are two varieties: the vascular, which occurs in the form of a definite fibro-angioma; and the hard, in which fibrous tissue and cartilage predominate. (Plate XXXVII, Fig. 4.)

These tumors of the nasopharynx, when they are benign, remain encapsulated, but in their growth they produce atrophy of the bone and other tissues and push their way forward through the nasal cavity and its sinuses; or they may enter the orbit and extend as far as the zygoma; or they may even break into the middle fossa of the skull and give rise to cerebral pressure.

Sarcoma.—The sarcomas are rare and they are practically incurable. In young individuals there is a form of sarcoma which is associated with adenoids. Up to the present time, even though recognized early, this tumor has proved incurable.

As shown in Fig. 606 it may be impossible to differentiate between the benign and the malignant forms of nasopharyngeal tumor.

Carcinoma.—This tumor is very rare in the pharynx, and especially in the nasopharynx. Up to the present time it has been found a hopeless lesion.

Cysts.—Cases of cysts in the nasopharynx have been reported, although very infrequently. They vary in size from a cherry to an egg. They contain yellowish mucoid material and cholesterin crystals. These cysts, which are probably of epithelial origin, can be recognized by aspiration, and they should be treated with the curette.

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* Deutsche Zeitschr. f. Chir., 1898, vol. xlvii., p. 100.

Other Benign Tumors.—Besides the fibroids, cysts, and adenoids, in the nasopharynx, teratomas have been observed. Ribbert looks upon the rare instances of enchondroma of the nasopharynx as representing remains of the chorda, and to these he gives the simple name of *enchondrosis physalifora spheno-occipitalis*. Lipoma, papilloma, and mucoid polypi similar to those observed in the nose have been described.

The Clinical Picture.—My personal experience with ten cases and a study of the literature have satisfied me that there is very little hope from operative treatment in cases of carcinoma or of the more malignant sarcoma of the nasopharynx. For this reason the patient should be given the benefit of the doubt, unless the diagnosis of a malignant tumor is positive, and he should be treated conservatively.

The importance of the clinical picture of nasopharyngeal tumors becomes apparent when we consider that it may allow us to recognize these tumors in the early stage—a stage in which they can be removed by intranasal or intraoral methods. When the tumors have reached great size it may become necessary to remove them by the more serious procedure of a temporary resection—an operation which allows a wider exposure of the nasopharynx.

Clinically, the congenital tumors may not give symptoms until later in life, or they may be recognized accidentally, as when the posterior nares are examined with the mirror. It is important to remember that adenoids—a lesion of childhood—frequently disappear, without operative intervention, at puberty. The appearance, later in life, of tumors like adenoids is suggestive of sarcoma. The common fibroids of the nasopharynx make their appearance between the ages of fifteen and twenty-five, sarcoma between thirty and forty-five, and carcinoma later.

The smaller tumors may be present for years without symptoms. As the tumor grows the patient observes nasal obstruction or difficulty of hearing, or he is bothered by a cough. Hemorrhage is very common in the case of the fibroids and is often excessive. In the malignant tumors hemorrhage is absent or slight.

As the nasopharyngeal tumor increases in size it more completely plugs the nares and presses down the soft palate, thus giving rise to mouth-breathing and to difficulty in respiration and in swallowing. The tumor in some cases may grow around the pterygoid process and be seen and felt in the region of the zygoma. This must be borne in mind when the differential diagnosis of tumors in the temporal fossa is attempted, as otherwise one might easily, in the case of a perfectly benign nasopharyngeal growth, interpret the simultaneous presence of an apparently independent tumor in the temporal fossa as a sign of malignancy. Extension of the growth into the orbit is associated with exophthalmos and change of vision. According to Simon somnolence is not a positive sign of cranial invasion.

Retropharyngeal Tumors.—Tumors may arise between the mucous membrane of the pharynx and the vertebræ. They originate in the periosteum related to the anterior ligament. It is practically impossible to differentiate them from the nasopharyngeal fibroids. Hellendall, who collected thirty-one cases, states that these tumors may fluctuate like a cold tuberculous abscess.

IX. Tumors of the Hard and Soft Palates and the Tonsil.

Primary neoplasms of the tissues of the hard and soft palates are relatively rare, while secondary involvement from tumors of the alveolar border and the body of the upper jaw are frequent. (Fig. 576.) The most common lesion of the palate is the syphilitic ulcer, which, in my experience, has never been difficult to differentiate from a carcinoma. The so-called mixed tumors of the parotid may be situated beneath the mucous membrane of the palate or in the region of the tonsils. Figs. 607 and 608 illustrate such instances. I have observed two cases in the region of the tonsils. These tumors are encapsulated and are curable by a very restricted operation. Looser* publishes an article in which he gives an interesting account of his own experience with tumors occupying unusual positions like the tonsil and the soft and hard palates, and to this account he adds an excellent résumé of the literature of the subject.

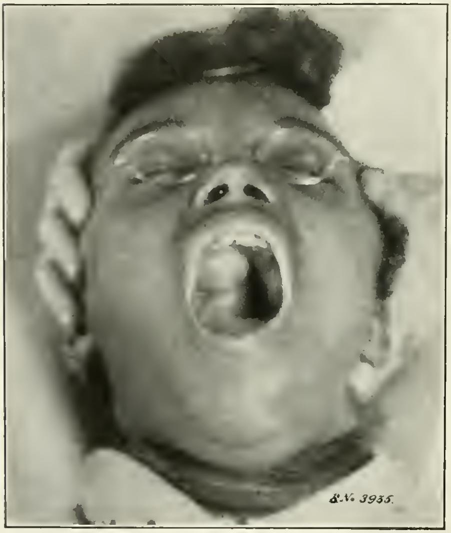

Fig. 607.—Surg. No. 3935, Halsted's Clinic. Mixed Tumor of Parotid Situated on Hard Palate.

I have had a large experience with mixed tumors of the parotid, and, as a matter of ordinary observation, without reference to the controversy as to their origin or the significance of their interesting cellular pathology, I feel warranted in saying that these tumors in the majority of instances are benign. It is safer, however, to remove a tumor of this kind, not only with its capsule, but also with a certain amount of the surrounding tissue. Recurrence has taken place after enucleation. In the region of the tonsil it may be necessary to enucleate. When this is necessary the wound should be cauterized with the Paquelin cautery.

Fig. 608 affords evidence of the danger of such enucleation. The original tumor, in this instance, was not larger than a bean. It was removed by enucleation under cocaine anæsthesia; it had been present one year. It is now almost two years since the recurrence, and the nodule has not increased in size. I have just removed it together with a zone of healthy tissue. Histologically, it is a tumor on the border line, between a fibroma and a sarcoma. Dr. William H. Welch describes the histology of this tumor to me in the following terms:—"In some places enough basement substance for a fibroma, in others so cellular as to be sarcomatous, and in the latter places of an alveolar type; the cells seem to be of a fibroblastic origin rather than endothelial. I do not make out a definite relation to blood-vessels. The cells are rather large and the type not that of a very malignant sarcoma. Still I should give it a wide berth in removal. I should call the tumor a fibrosarcoma."

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* Beitraege z. klin. Chir., 1906, vol. lii., p. 261.

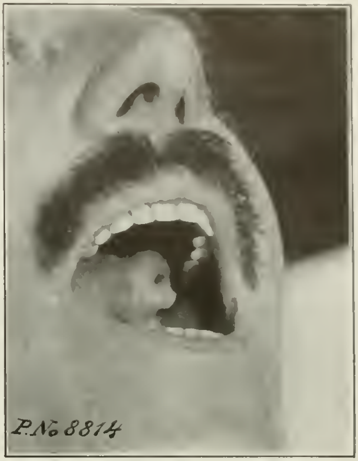

FIG. 608.—Pathol. No. 8814. Author's Case. Fibroma or Fibrosarcoma of Hard Palate and Gum Opposite the Last Molar Tooth of the Upper Jaw. The tumor had been present one year when it was enucleated. It recurred almost immediately.

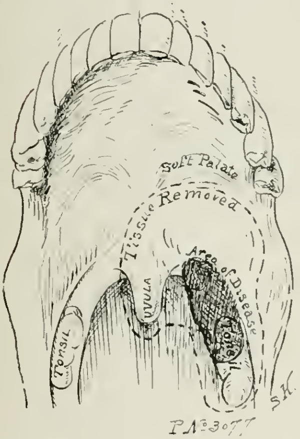

FIG. 609.—Pathol. No. 3077. Johns Hopkins Hospital. Diagram of Carcinomatous Ulcer of Tonsil and Soft Palate. White male, aged fifty-nine years; ulcer four months. Excised locally only. (Halsted.) No recurrence eight years after operation. For microscopic picture see Fig. 595.

Fig. 3 of Plate XXXIX is a beautiful illustration (drawn by Miss Hayes) of a diffuse adenopapilloma which involved the hard palate. At its base it had become malignant and had infiltrated the bone of the upper jaw. This tumor recurred in spite of the most extensive excision. It was a recurrent tumor which had existed for twelve years. I have observed two instances in which this lesion was histologically benign and in which there has been no recurrence after operation. This form of papilloma is not uncommon in the hard palate.

Primary carcinoma affects the tonsil more frequently than it does the hard or the soft palate. Among twelve cases of which I have records there were six which were inoperable. Among the six cases which were subjected to operation there has occurred only one permanent cure; and it is very interesting to note that, in this instance, the ulcer which involved the tonsil and soft palate was removed only locally. It is eight years since the operation was performed by Dr. Halsted, and there has been no evidence of recurrence. (Fig. 609.) In the remaining five cases very extensive local operations were performed and the affected lymph nodes were thoroughly extirpated, but nevertheless two post-operative deaths have occurred and there have been no permanent cures. Such results can scarcely fail to make one hesitate to perform more than a local operation in a case of carcinoma of the tonsil or the soft and hard palates. Fig. 610 illustrates the result of a recent attempt of my own (in a case of very early carcinoma of the tonsil) at a very extensive operative removal, not only of the diseased tonsil but also of the adjacent part of the lower jaw. The tumor, however, although it had apparently existed for only two weeks, must have infiltrated deeply the tissues situated posteriorly, because the patient died of recurrence in the post-pharyngeal lymph nodes. My study of these cases leads me to believe that metastasis will take place first to the inaccessible lateral and post-pharyngeal lymph nodes, and consequently the extensive removal of the nodes below the jaw cannot increase the probabilities of a cure, but only the operative mortality and the degree of mutilation.

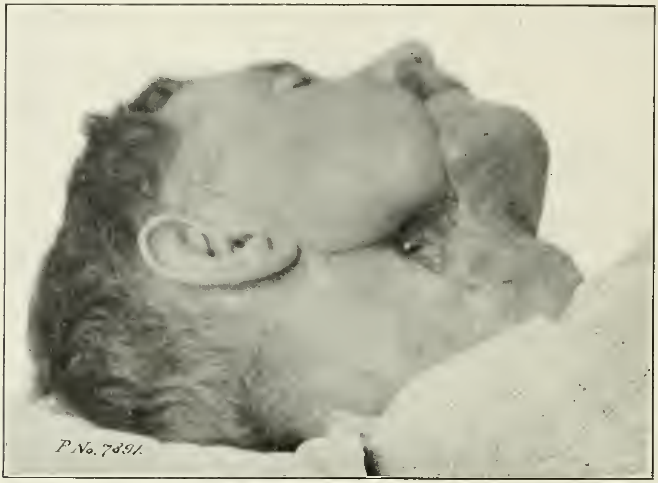

Fig. 610.—Pathol. No. 7891, St. Agnes Hospital, Dr. Bloodgood's Clinic. Photograph of Result Six Weeks After Operation for Carcinoma of Tonsil. White male, aged forty years; ulcer two weeks; disease not cured by operation.

X. Tumors of the Temporal Fossa.

In the temporal fossa I have observed a few cases of tumor which are especially instructive from the standpoint of differential diagnosis; and I am of the opinion that in every instance of this kind an exploratory incision should be made, because, on the one hand, the very malignant tumors are inoperable, and, on the other, mutilating operations are not only dangerous but unnecessary for the curable lesion.

I have observed a tumor of the temporal fossa which, at the exploratory incision, proved to be an inoperable sarcoma arising from the periosteum of the cranial bone. In two other cases in which the clinical picture did not differ enough from this case to allow a differential diagnosis, at the exploratory operation, pus was found and both patients recovered.

In the very interesting case of dermoid cyst of the temporal fossa, reported and illustrated by Dr. J. Shelton Horsley, of Richmond, Va.,* the huge tumor was eradicated in the belief that it was a sarcoma. Death resulted. If an exploratory incision had been made, I am confident that the benign nature of the lesion would have been recognized and that the more conservative operation indicated would have proved less dangerous. The procedure followed by Dr. Horsley is, however, the one usually employed, but I trust that I have been able in this article to present the subject in such a way that, in the future, surgeons will make a positive diagnosis before resorting to extensive operations for tumors of, and in the region of, the jaws.

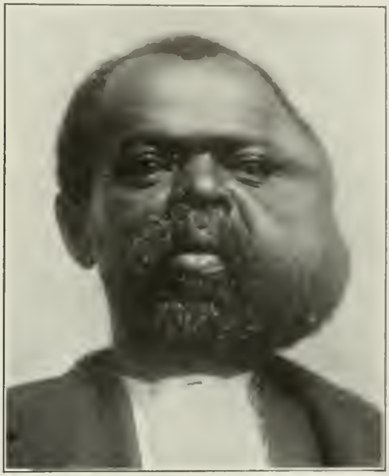

Fig. 611.—Pathol. No. 8007, Dr. Horsley's Case. Dermoid Cyst of Temporal Fossa.

Fig. 611 is a photograph of Horsley's patient. In my experience a tumor of this size, of two years' duration, would be hopeless if it were a carcinoma in a dermoid cyst, or one of the more malignant sarcomas. The probabilities would be in favor of the assumption that the tumor was benign or one of the less malignant sarcomas. It should have been removed by enucleation.†

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*Annals of Surgery, 1907, vol. xlvi., p. 716.

†Dr. Horsley gave me the opportunity to study the tissues removed in this case, and I am confident that he will understand that my remarks are general and not at all personal.

II. OPERATIONS FOR TUMORS OF THE ALVEOLAR BORDER, THE BODY OF THE JAW, THE ANTRUM, THE ORBIT, THE HARD AND SOFT PALATES, AND THE NASAL CAVITIES.

Tumors of the Alveolar Border.—For ossifying periostitis and exostosis one should turn back a muco-periosteal flap and should extract only such teeth as are diseased and which would be extracted in any event. This exposes the new-growth of bone. In the lower jaw one can, as a rule, find the line of separation between this osseous growth and the body of the jaw. As much of the new-growth as possible should be removed without interfering with the continuity of the body of the jaw. On the body of the upper jaw one must exercise greater care, and smaller pieces should be chiselled away. If one proceeds in this careful manner the thin bony capsule of the antrum will be preserved and the antrum cavity will not be opened. After the bone has been removed one should attack the periosteum of the muco-cutaneous flap, trimming it away with scissors or destroying it with the Paquelin cautery. If bleeding is not marked the flap can be replaced, but in some cases it will be necessary to pack with gauze for a few days. One should expect a slight recurrence of bone formation, but second operations are rarely necessary.

For the cure of the connective-tissue epulis discussed on page 818, as well as for the cure of the adamantine epithelioma of the alveolar border (page 843), a slightly more extensive local operation is demanded. The alveolar growth is encircled with a knife in such a manner as to leave a collar of uninvolved mucous membrane. These flaps composed of soft parts are dissected until the body of the jaw, along the line where the soft parts join the alveolar border, is exposed. At this stage the open wound will require packing with gauze to check oozing. The periosteum is next divided and pushed back; then the alveolar border beyond the confines of the tumor is cut through with the bone forceps. This removes the alveolar tumor with a margin of mucous membrane and bone. Now one should attack the tooth cavities beneath the tumor. This is best done with a curette and the Paquelin cautery. The operation is therefore in some cases performed in a piecemeal fashion, but if the curette and Paquelin cautery have been employed I have never known a recurrence to take place. It is not necessary, in the removal of these tumors, to destroy the continuity of the body of the lower jaw, or to open the antrum cavity in the upper. I have performed the entire operation under cocaine anaesthesia. The bone forceps is a safer instrument than the chisel. I have known the body of the lower jaw to fracture in the attempt to chisel the alveolar border.

As stated before (page 821), it is justifiable, in younger individuals, to attempt removal of the epulis with the preservation of the teeth, if they are not decayed. That this can be done successfully is shown in Fig. 558.

Tumors of the Lower Jaw.—The typical resection of the lower jaw is not a difficult procedure. The skin incision, of course, varies with the nature of the growth. In some cases it is best to carry the skin incision from the angle to the symphysis, beneath the body of the lower jaw. This skin flap can be turned up. If but a portion of the jaw is to be removed, it may not be necessary to carry the incision to the mouth, but in some cases it facilitates the resection to carry the incision to the angle of the mouth, or from the symphysis to the middle of the lower lip. The lower jaw should be divided with the Gigli saw, and it is better to make the first division anteriorly; then one can grasp the bone, withdraw it outward, and remove as much as is indicated by the extent of the tumor growth.

The technical difficulties in resection of the lower jaw are, as already stated, not very great. The point which I am particular to emphasize in this contribution is that the so-called typical resection should be avoided, and that the amount of bone to be removed should be governed entirely by the pathology of the tumor.

In the periosteal osteosarcoma the entire tumor must be removed. (Fig. 565.) This tumor always has a thick capsule, and the outlines, both of the soft parts and of the bone, are sharply defined. On the other hand, in the case of the periosteal fibrosarcoma and fibromyxosarcoma (Fig. 567) I am of the opinion that the bone may be preserved. When the tumor is first removed the bone should be left intact, and then afterward some of the bone may be bitten away with rongeur forceps. For this variety of tumor such a conservative procedure is justifiable, and, in my own experience, it is not followed by recurrence.

When the exploratory incision has revealed the fact that the tumor is a spindle-cell-and-round-cell periosteal sarcoma of the lower jaw (Fig. 568), one is justified in attempting a very radical local excision; but even this procedure, up to the present time, has not accomplished a cure.

For the rare medullary tumors of the body of the lower jaw (Figs. 569, 570, and 571) one should be content with curetting or with subperiosteal resection, and in many of the cases the continuity of the lower jaw may be preserved.

Tumors of the Upper Jaw.—The same principles as those set forth above should govern the surgeon in his operative procedures upon antrum tumors. One should never proceed with the typical resection of the upper jaw—an operation which is mutilating on account of its destruction of the teeth and alveolar process—until the character of the tumor is ascertained by an exploratory incision. Up to the present time the records show no permanent cures of the more malignant antrum tumors—the carcinomata and the spindle-cell-and-round-cell sarcomata. My experience teaches me that the fibrosarcoma and the fibromyxosarcoma of the antrum (Figs. 573 and 574) can be removed by a very conservative operation.

Dental-Root Cysts, Dentigerous Cysts, Adamantine Epithelioma. The procedures required in the operative treatment of these lesions have been discussed along with the clinical picture and pathology of these tumors. (See page 834.)

The position taken by me in regard to the operative treatment of the tumors of the upper and lower jaws is radically different from that advised in the majority of modern text-books. This view, however, has been forced upon me by the study of these cases, and it is beginning to be the view taken by others in their publications, after a similar careful clinical and pathological investigation.

Carcinoma with Secondary Involvement of the Upper and Lower Jaws.—In this group of tumors the attitude of the surgeon should be entirely different from the one which I have just advocated; he should adopt a more radical procedure. This is based upon the fact that the local growth of a carcinoma is different from that of a sarcoma; and experience has shown that a permanent cure of a carcinoma depends upon a more radical local extirpation, combined, in the majority of cases, with an excision *en bloc* of the neighboring lymph nodes and their surrounding tissues.

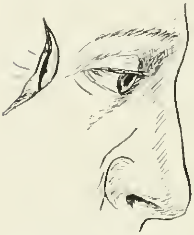

Fig. 612.—Skin Incision for Kroenlein's Osteoplastic Operation. (From Domela-Nieuwenhuis, in *Beitr. z. Klin. Chir.*, 1900, vol. xxvii.)

The curable sarcoma can be cured by a less radical local operation. The more malignant sarcoma kills by metastasis, and the results are not improved by a more radical local operation.

In all forms of carcinoma the local operation should be more extensive than that which is required for sarcoma, and, in the majority of cases, it should be combined with the removal of the lymph nodes and lymph vessels.

When these extensive operations are performed on the upper or the lower jaw it facilitates the technique to expose the common carotid and place upon it a temporary ligature with Crile's clamp. Crile and many other surgeons prefer to give the anæsthetic through tubes which are introduced into the nose, the pharynx at the same time being packed with gauze. Halsted, Kroenlein, and others prefer to have the patient in Rose's position during that stage of the operation in which there is any danger of aspiration of blood. I prefer the latter position, because, as demonstrated by Kroenlein, it allows the operation to be done with the least amount of anæsthetic. It is possible, in the majority of cases, if the dissection is performed slowly and bloodlessly, as it should be, to finish the operation without being bothered very much by the accumulation of blood in the pharynx.

Orbital and Retrobulbar Tumors.—The most important special procedure for the exposure of retrobulbar tumors, with the object of preserving the eye and restoring the continuity of the bony orbital fossa, is the so-called osteoplastic resection of Kroenlein, first described by Domela-Nieuwenhuis.* The steps of the operation are as follows:—A curved incision, with the convexity toward the eye (Fig. 612), is made through the skin over the temporal fossa. This exposes the outer rim of the bony wall of the orbit and enables one to make a periosteal and osseous flap which is afterward replaced in its proper position. Fig. 613 illustrates the line of division of the bone and the shape of the piece removed. The principle of making this flap is the same as that employed in the osteocutaneous flap required for gaining access to the cranial cavity. Care must be exercised not to sever the soft part of the flap from the piece of bone to which it is adherent. In separating the contents of the orbital cavity from the bone flap special care is required to avoid injuring the eye and infraorbital vessels and nerves.

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* Beitraege z. klin. Chir., 1900, vol. xxvii., p. 559.

Tavel,* following the modern principle of Kocher, which aims to avoid dividing branches of the facial nerve in operations upon the face, has modified Kroenlein's procedure in such a manner as not to injure the orbital branch of the facial nerve. This modification is best described by the reproduction of his illustration (Fig. 614).

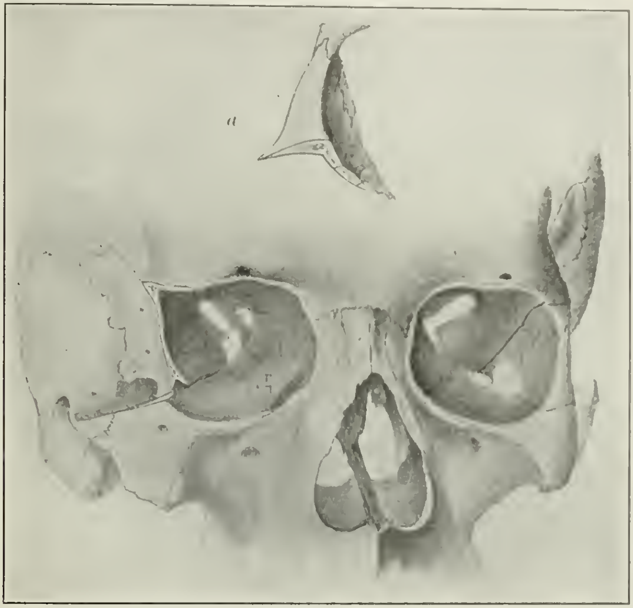

Fig. 613.—Kroenlein's Osteoplastic Resection of Orbit. Lines of bone incision marked on left orbit; defect shown in right orbit. *a*, Piece removed. (From Domela-Nieuwenhuis, *op. cit.*)

In my limited experience with orbital and retrobulbar tumors, all of which up to the present time have been malignant, I have not employed Kroenlein's method. That a part of the bony orbital wall can be removed without much deformity is shown in Fig. 601. In this case the tumor occupied the lower and outer quadrant of the orbit, and had broken through the orbit into the antrum, but the rim of the orbital fossa had not been destroyed. The line of incision which was adopted, and which avoided inflicting any injury upon the facial nerve, is shown in Fig. 614. The osseous rim of the orbital fossa, from the external angular process of the frontal bone down to the infraorbital canal, was removed by chiselling, and all the bony anterior wall of the antrum was also removed. The tumor had destroyed the thin septum of bone between the orbit and the antrum. It is evident, as it seems to me, that one must modify the operation to meet the requirements of the case. I am inclined to feel that in the majority of instances the facial nerve can be preserved and that in tumors which are strictly orbital Kroenlein's osteoplastic procedure may be followed.

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*Deutsche Zeitschr. f. Chir., 1907, vol lxxxvii., p. 561

In carcinoma of the orbit, when it becomes necessary to remove the eye, the dissection of the orbital tissues should be very complete, as shown in Fig. 605. This may best be done by exposing the periosteum along the bony rim of the orbit and then separating it from the underlying bone until the optic nerve and its accompanying vessels shall have been exposed. In a few of my cases complete enucleation was possible, except at the position of the optic nerve. At this point I could see with the naked eye—and this was subsequently confirmed by an examination with the microscope—that carcinomatous tissue had grown along the optic nerve into the skull cavity. In these patients there was a local recurrence of the cancerous disease, and death, with symptoms of cerebral tumor, followed. I did not think it justifiable in these cases to proceed with any further attempt by opening the skull.

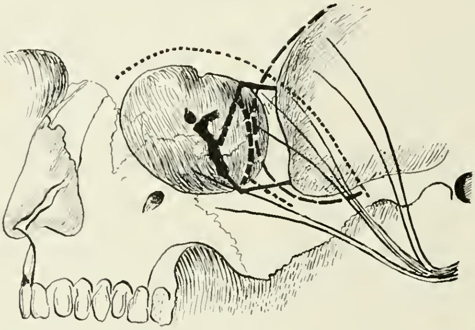

FIG. 614.—Tavel's Modification of Kroenlein's Operation; skin incision to avoid injury of facial nerve. (*Deutsche Zeitschr. f. Chir.*, 1907, vol. lxxxvii., p. 561.)

— — — Kroenlein's skin incision.

- - - - - - Tavel's skin incisions.

▬▬▬ Chisellings through bone.

▮▮▮▮▮▮ Lines of resection of outer orbital wall.

Retropharyngeal Tumors.—There is the greatest difference of opinion in regard to the treatment which should be adopted in cases of this nature. Some advocate the most radical kind of removal, while others claim that it is best to leave the growths alone. When their existence is recognized at an early date, I believe that intranasal or intraoral treatment will suffice. In the case of a young individual one may take a conservative stand as regards the benign fibroids, because in many cases they disappear at puberty.. When the tumor, however, grows, or when there are recurrent hemorrhages, operative interference is demanded.

In very large benign tumors, such as I have illustrated in Fig. 606, operation should be performed; but if the tumor is malignant, nothing will be accomplished, of course, by operative interference. Many of these huge benign tumors have been successfully removed, and a fatal issue from hemorrhage or from obstruction has thus been prevented.

Although there are many methods of operating, Kocher's temporary resection of both halves of the upper jaw is apparently the best.

Kocher's Osteoplastic Resection of Both Halves of the Upper Jaw.—This method, although devised by Kocher, was published by Lanz in 1892.* Tracheotomy is performed; the pharynx is packed; in some cases the external carotid arteries are ligated; a longitudinal incision is made through the upper lip down to the bone; the mucous membrane of the alveolar border is divided transversely; the periosteum is stripped back; a chisel is employed to divide the alveolar processes of the upper jaw horizontally; the two halves of the upper jaw are separated in the middle line; the soft palate is not always cut through; the wound is packed with gauze for a few minutes; and then, when the packing is removed, it will generally be found practicable (the hemorrhage having ceased) to make a direct attack upon the tumor.

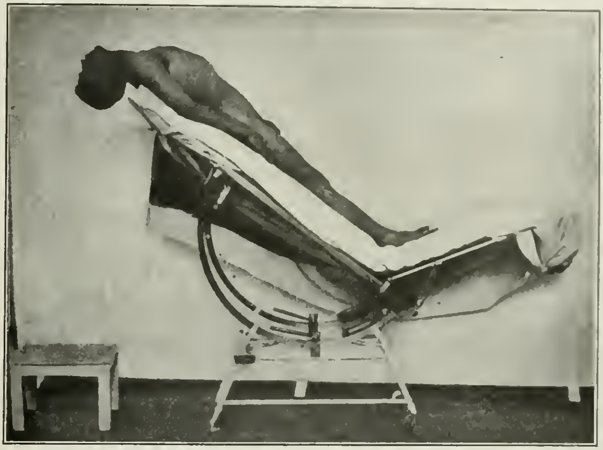

Fig. 615.—Payr's Position for Operations on the Nasopharynx. (From Payr in *Archiv f. klin. Chir.*, 1903, vol. lxxii., p. 284.)

Payr recommends a modified Rose position (Fig. 615), and does not perform tracheotomy. Fig. 616 represents the patient (the same as the one shown in Fig. 606), at the time of the operation, in Payr's position. The entire Kocher's temporary resection had been completed and the wound packed preliminary to attacking the tumor.

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* Deutsche Zeitschr. f. Chir., vol. xxxv., p. 43.

Kammerer, of New York, reports a successful case.* The ultimate result in this case is shown in Fig. 617. The deformity, as will be remarked, is insignificant. Kammerer ligated both external carotids, used Payr's position, did not perform tracheotomy, and did not divide the soft palate. He does not state whether or not there was much hemorrhage. The tumor was easily exposed and its attachment to the base of the skull was separated by blunt dissection; the slight venous oozing which occurred at that moment was controlled by a tampon. Kammerer, therefore, was very fortunate in his experience with hemorrhage. In Kammerer's case the tumor had destroyed the bony base of the

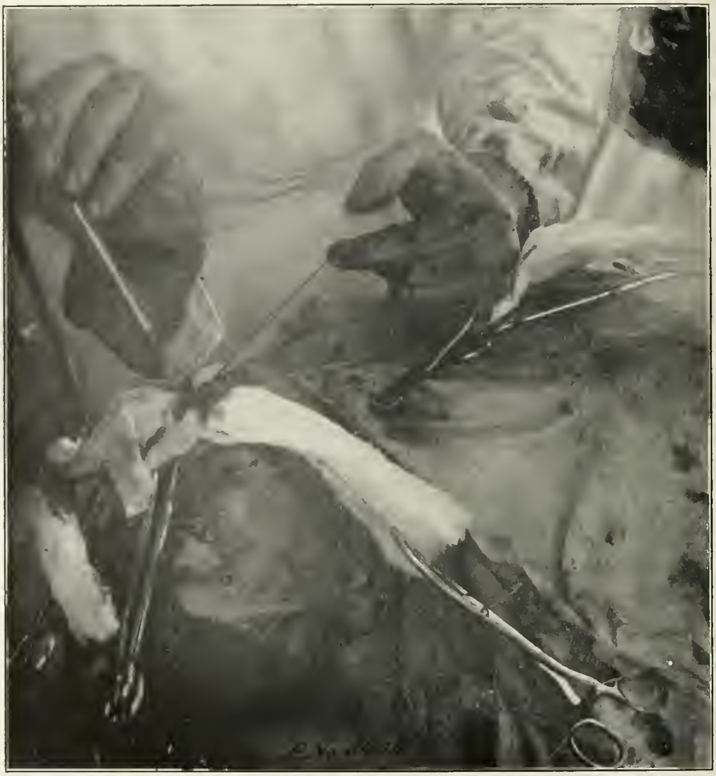

Fig. 616.—Pathol. No. 8404. Author's case. Photograph Taken at Operation on Patient Exhibited in Fig. 606. Kocher's temporary resection of both upper jaws. Picture taken just before the last act (chiselling in the middle line of the upper jaw) of the operation. The patient is in Payr's position. (Fig. 615.)

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*Transactions of American Surgical Association, vol. xxv., 1907, p. 293.

skull, and when the tumor was removed the dura was seen and pulsations of the brain were observed. This possibility in benign tumors has been mentioned.

I believe that in these cases it might be better to ligate one external carotid and temporarily clamp the common carotid on the side corresponding to the attachment of the nasopharyngeal tumor. Crile prefers to give ether through a tube introduced into the mouth and to tampon the pharynx. I agree with Payr that this method is not necessary, and I acted upon this belief in my case. The tampon is in the way, and now and then, even when it is applied by experienced hands, it may have to be removed, which would be a serious complication at some of the critical moments of this operation. Kroenlein, in his work on the operative treatment of tumors of the upper jaw, has shown that light anæsthesia is best. Kuhn intubates and packs the pharynx about this intraoral tubage.*

Nurok† reports a number of successful cases in which the nasopharyngeal tumor was extirpated through the space gained by a temporary resection of the hard and soft palates.

Intranasal Diseases.—From what has just been said it can be easily inferred that when intranasal tumors are referred to the general surgeon for operations other than intranasal, the prognosis, with a few exceptions, is hopeless. There are a few benign intranasal growths which can be more completely removed and with less risk than by the intranasal method. In view, however, of the hope that intranasal malignant disease will be recognized earlier, surgeons should be familiar with the more approved methods of attacking such lesions through an extranasal operation.

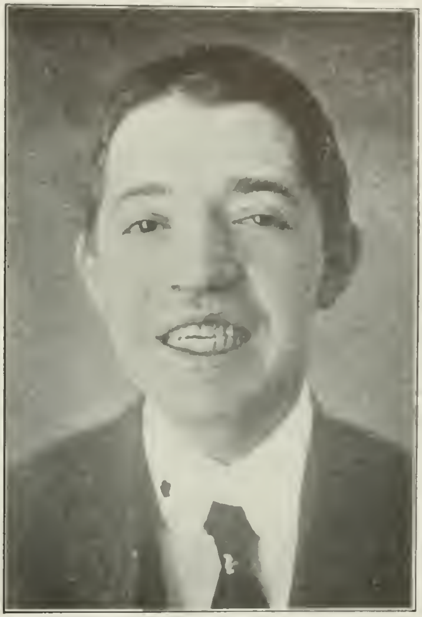

FIG. 617.—White Male, Aged Twenty-one Years; two and a half years after bilateral temporary resection of both superior maxillæ (Kocher) for tumor of nasopharynx. (From Kammerer, Transactions of Amer. Surg. Asso., 1907, vol. xxv., p. 293.)

Radical Procedures.—When the nasal growth has invaded the antrum or orbital cavity one should proceed with its removal in nearly the same way as in the operation already described for excision of the upper jaw, and it is my opinion that, in every operation for a malignant nasal tumor, whether the antrum or the orbital cavity be involved or not, the operation should proceed through the cavity of the antrum. A flap from the cheek should be turned down, the incision starting at the upper lip and following the line of the nose to the angle between the nose and the eye. Then a curved incision should be carried from a point below the eye to the zygoma. The flap thus outlined should be turned back and down. With a bone forceps the connection between the nasal bone and the superior maxilla is divided and the nose is dislocated toward the opposite side. This gives access to the nasal and antrum cavities. One can remove most of the anterior bony wall of the antrum and the floor of the orbit, and in this way secure a fairly wide exposure. The alveolar border and the hard palate of the upper jaw may be preserved. This procedure is less radical than the total resection of the upper jaw, and I am inclined to the opinion that one should give this method the preference, as it is less mutilating and as, in any early operable case, it offers as much hope of a permanent cure as may reasonably be entertained.

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* Centralbl. f. Chir., 1906, vol. xxxiii., p. 241.

† Centralbl. f. Chir., 1908, vol. xxxv., p. 671.

Less Radical Procedures.—The number of operations which are described by Harmer and Glas, and pictured by Bryant and von Esmarch in their text-books on operative surgery, is almost as great as the number of possible tumors. Each operation is based on the principle of a temporary resection which allows an exposure of the nasal cavity and the removal of the intranasal growth with the least permanent deformity. None of these operations appears to me to be feasible for malignant tumors.

The temporary resection of the nose (Chassaignac's method and von Langenbeck's method) may be employed for the removal of those benign polypi which, on account of their size and position, are inaccessible to intranasal operation.

With the evidence at hand I am more firmly convinced than ever that benign intranasal lesions are accessible to intranasal methods in the hands of the expert, that malignant lesions should be recognized earlier by the routine microscopic examination of pieces excised for diagnosis, and that for such tumors only the more radical extranasal operations should be performed, the most radical of which consists of complete excision of the upper jaw. But I would suggest that a somewhat less radical procedure should be employed,—one in which the alveolar border and palate of the upper jaw are preserved (unless, of course, these areas are involved). I feel that all the other very ingenious methods are of historical interest only.

III. INFLAMMATION OF THE JAWS AND THEIR SOFT PARTS.

With good dentistry and thorough care of the mouth and teeth the chief portals of entrance for the more serious inflammations are excluded.

In the inflammatory swellings about the teeth and the upper and lower jaws, one must make a differential diagnosis from new-growths. In my experience, this has not been a very difficult procedure. *In the few cases in which a differential diagnosis seemed impossible I have always treated the lesion as if it were inflammatory, because I was quite convinced that any new-growth associated with so much infiltration would be hopeless from the standpoint of operative removal. This rule will be found to be a good one in other localities besides the jaws.*

Perthes *(op. cit.)* recognizes a hæmatogenic ostitis of the jaw, with and without a preceding infectious disease. Then he describes two kinds of periostitis and osteomyelitis—one secondary to infection through the teeth or from inflammations of the gums, the other traumatic, following the extraction of teeth, or from fractures. Among the specific inflammations tuberculosis, actinomycosis, and syphilis must be borne in mind. Among the toxic inflammations the necrosis of phosphorus and that of arsenic are not infrequent, and in addition there is a similar inflammation with necrosis among the workers in mother-of-pearl.

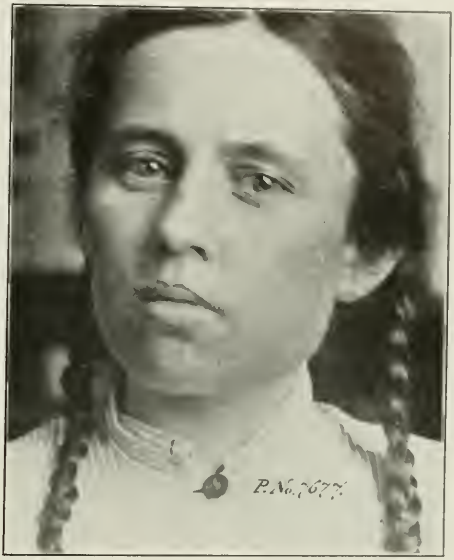

Fig. 618.—Pathol. No. 7677. Author's case. Hemorrhagic Periostitis of Left Lower Jaw, traumatic in Banti's disease. White female, aged twenty-two years; symptoms four days

In the majority of cases the infection begins in the gum or about the teeth and rarely involves a large area, nor is it associated with much necrosis of bone. In the upper jaw the chief danger is an antrum suppuration, while in the lower jaw the periostitis, if not checked, may lead to total necrosis. In some of the cases the perimaxillary phlegmon (cellulitis of the neck, floor of the mouth, and pharynx) is the most serious complication, while in a few rare instances there may be an extensive thrombophlebitis which may eventually extend to the veins of the brain.

In the more chronic cases one must carefully examine for tuberculosis, the ray fungus, and the Spirochæte pallida, and must also think of the possibility of some toxic substance like phosphorus or arsenic.

Hemorrhagic Periostitis.—I have called attention, in the section relating to tumors of the alveolar border, to a peculiar uniform hypertrophy of the gums associated with leukæmia (Figs. 555 and 556), and here I wish to emphasize the fact that, in some of the grave anæmias and diseases of the blood accompanied with bleeding from the gums, there may occur, after traumatism and especially after extraction of teeth, a sudden swelling of the body of the lower jaw accompanied by redness, tenderness, and œdema. At first sight this resembles acute purulent periostitis, but there is neither fever nor septic leucocytosis. Fig. 618 is a photograph of an interesting and rare observation of this nature. The patient, a white girl aged twenty-two, had passed through an attack of typhoid fever five years previously, and since that time she had observed redness and bleeding from the gum. Four days before she came under my care a profuse hemorrhage from the gum had taken place, and the swelling of the lower jaw had then made its appearance. The pigmentation, the appearances presented by the blood, and the large spleen indicated Banti's

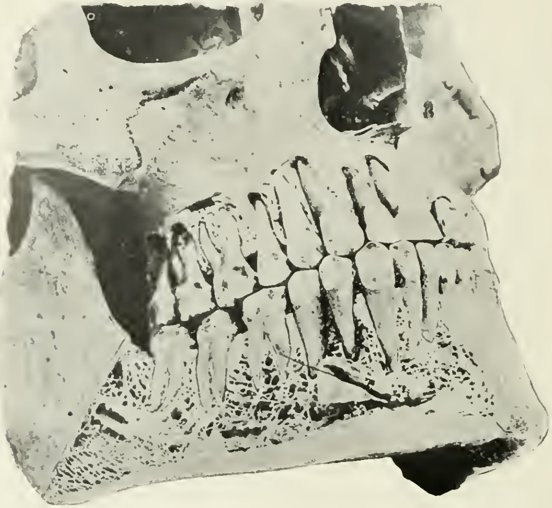

Fig. 619.—Anterior Lateral View of the Upper and Lower Jaws, with the external cortical portion of the bone covering the roots of the teeth removed, exposing the cancellated tissue, the roots, and the cribriform tubes. (From Cryer's "Internal Anatomy of the Face.")

disease. The swelling of the jaw disappeared in about ten days. This patient has now been under my observation for a period of three years and there has been no recurrence of the hemorrhagic periostitis.

Infections Through and About the Teeth.—The permanent tooth (Fig. 619) is embedded in a bony sac, the alveolar process of the jaw. This is well shown in the figure. The bone forming the tooth sac is lined with periosteum; this periosteum is reflected about the root of the tooth, the two surfaces coming in contact. This tissue is unusually vascular and sensitive. Surrounding the so-called neck of the tooth, between the root and the crown, there is connective tissue, quite vascular, covered with squamous epithelium. This is called the gum, and this gum tissue is intimately connected with the periosteum. While the periosteum is sensitive, the gum is not so. The enamel crown of the tooth extends a little below the gum. The body of every tooth is pierced by a canal, and this canal enters one or more roots. These root canals are the chief portals of entrance for infection when the enamel has been injured and the dentine exposed. When dentists fill teeth without disinfecting the root canal with a fine needle dipped in carbolic acid, there is frequently trouble. Whenever there is tenderness of a tooth, with tenderness and swelling about its root, search should be immediately made for the cavity, and the root canals should be disinfected. I wish to emphasize this point, because in my experience most surgeons and not a few dentists are ignorant of this important point. The surgeon and dentist must consult together, and I am confident that many serious

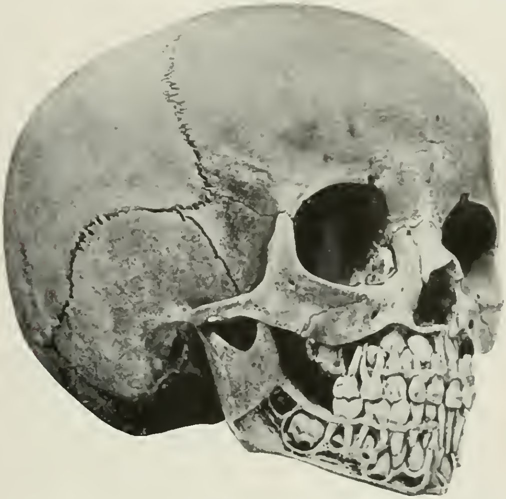

FIG. 620.—Skull of Child, aged six years, illustrating the deciduous teeth in position and the development of the permanent teeth. (From Cryer, "Internal Anatomy of the Face," S. S. White Dental Mfg. Co., Philadelphia, 1901.)

infections of the upper and lower jaw can be prevented by early exposure and disinfection of the root canal.

When the infection extends beyond the tooth we have an alveolar periostitis. This may lead at once to a gum boil or an abscess, with or without necrosis. If unchecked and of a virulent character, the alveolar periostitis of the lower jaw may extend and lead to total necrosis. This occurs very infrequently in the upper jaw where extension is chiefly into the antrum. The close relation of the roots of the teeth of the upper jaw to the antrum cavity are shown in Fig. 619.

Non-Erupted Teeth.—Fig. 620 shows the relations of the erupted and non-erupted teeth in a child, and Fig. 621 a non-erupted wisdom tooth. These relations must be borne in mind in obscure infections of the upper and lower jaws. An *x*-ray picture will always show the presence of a non-erupted tooth, and dentists to-day are employing the *x*-ray for diagnosis with most gratifying results.

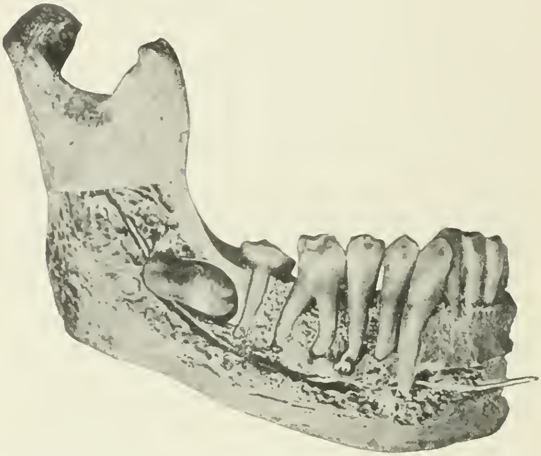

FIG. 621. Impacted Lower Third Molar Tooth, with pressure on the infradental nerve; symptoms of neuralgia. Diagnosis could be made by *x*-ray. (From Cryer, *op. cit.*)

Gingivitis or Stomatitis.—As compared with infections of the teeth, primary infections of the mucous membrane of the alveolar border, or the so-called gum, are relatively infrequent causes of osteomyelitis. Mercurial gingivitis is not difficult to recognize. Rarely is it followed by alveolar periostitis and necrosis. The blue line on the gum in lead poisoning never goes any further. With the bleeding of gingivitis in scurvy, purpura, and hæmophilia there is practically never any secondary involvement of bone. The very virulent forms of stomatitis in children are always accompanied by gingivitis, but seldom go on to periostitis and osteomyelitis. The mucous patches of syphilis and the soft characteristic ulcers of tuberculosis, although not frequent, should be recognized when situated on the gum.

Riggs' Disease (Pyorrhœa alveolaris).—In this rare lesion there is a scanty purulent secretion associated with atrophy and recession of the gum. The tooth is exposed beneath the enamel. In more advanced cases the tooth becomes loose, and the disease, if unchecked, leads to the loss of teeth.

Pulpitis and Gingivitis.—Pulpitis (inflammation of the tissue filling the canal of the tooth) and gingivitis are diseases easily controlled by good dentistry and cleanliness. In my experience every individual who has difficulty in keeping the teeth clean should be given a tooth paste or powder containing some potassium chlorate. Now and then there are no symptoms of the low grade of inflammation, except a little bleeding and tenderness of the gum. Potassium chlorate acts as a specific in such cases.

Different Forms of Periostitis and Osteomyelitis.

The relative proportion of grave and slight infections of the upper and lower jaws can be demonstrated by the following statements in regard to sixty-eight cases of which I possess good records.

Among thirty-five cases involving the lower jaw there were but two examples of tuberculosis, and but four in which there was complete necrosis of the body of the lower jaw. In the remaining cases the periostitis was associated with some slight necrosis of the alveolar border in fifteen cases, and with partial necrosis of the body of the jaw in fourteen cases. But this necrosis leads to no deformity. In the remaining two cases the infection was confined to the soft parts only. Osteomyelitis of the jaw secondary to fracture or a bullet wound is rather infrequent. Most fractures properly treated heal without necrosis.

It will be observed that in infections of the lower jaw total necrosis and tuberculosis, which is usually associated with total necrosis, are not very frequent complications.

Among twenty-four cases in which there was infection of the upper jaw there were fifteen in which the disease was associated with antrum suppuration. Total necrosis of the upper jaw was not observed in a single instance. Alveolar periostitis with slight necrosis of the alveolar border was present in nine cases.

Early intervention is more important in infections of the upper than in those of the lower jaw, for the danger arising from total necrosis of the latter is less serious than the danger which is associated with involvement of the antrum.

Alveolar Periostitis.—The pain from an alveolar periostitis is not distinguishable from that of an ordinary toothache; but, when the inflammation is confined to the tooth (pulpitis), the tooth is tender, and, when it has extended to the alveolar periosteum, tapping of the alveolar border is extremely painful, and there is swelling in this locality. There is not much difficulty in making the diagnosis. The question always arises as to when an incision should be made. If there are simply tenderness and a little swelling it is justifiable first to treat the tooth: but if the case is seen late, and if the œdema and swelling have extended to the cheek from the upper jaw, or to the tissues over the body of the lower jaw, an incision should be made at once under local anæsthesia. Pus is usually encountered. The incision should be carried to the bone. Now and then no pus is found, but the symptoms are relieved. In some cases the alveolar abscess from the periostitis is of a subacute or chronic character and ruptures spontaneously. In such cases the focus of disease is more apt to be in the root than in the alveolar bone, and the treatment should be first instituted by the dentist.

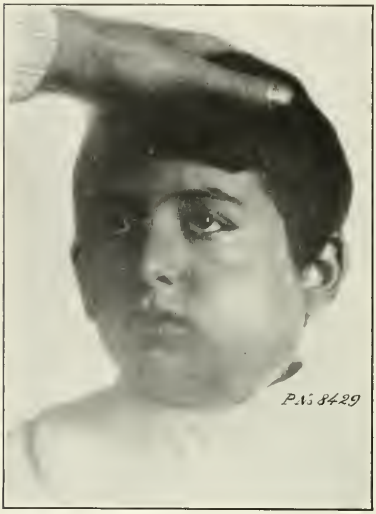

Fig. 622.—Pathol. No. 8429. Author's Case. Submaxillary Abscess associated with pulpitis of a molar tooth of the left lower jaw, but with no evidence of alveolar periostitis. Cured by extraction of tooth and incision of abscess.

Early incision, in alveolar periostitis, will, I am confident, prevent the involvement of the antrum in infections of the upper jaw, and necrosis in infections of the lower jaw.

Metastatic Infections of the Neck in Alveolar Periostitis.—Now and then an abscess forms in the neck with no evidence of infection of the lower jaw except a carious tooth, or an abscess may develop in the antrum or the temporal fossa from a pulpitis of a tooth in the upper jaw. In Fig. 622 is shown a very large abscess in the submaxillary triangle of the neck. In this patient nothing could be found but a tooth in which there was a cavity. These abscesses, which are most frequent in children, may arise without any prodromal symptoms on the part of the carious tooth. It is from observations like this that one learns the importance of frequent dental supervision of the teeth in children.

It is only necessary in these abscesses to open and drain them. A small incision is sufficient; the scar need never be disfiguring.

Sinuses in Chin and Neck Secondary to Pulpitis or Alveolar Periostitis.—Clinically, these sinuses fall, as a rule, into two groups. In the smaller group there is a history of spontaneous rupture or incision of an abscess, as illustrated in Fig. 622; in the larger group the symptoms are chronic, and the sinus appears, without previous warning, in the neighborhood of the chin or in some dependent position in the neck. In my experience, in addition to the treatment of the tooth, it is generally necessary to excise such a fistula. It is justifiable, however, as a preliminary treatment, to try disinfection with pure carbolic acid followed by alcohol, and then to inject the bismuth-vaseline paste of Beck.

Alveolar Periostitis with Necrosis of the Alveolar Border. The symptoms do not differentiate this lesion from the simple periostitis without necrosis. As a rule, this complication is encountered only when treatment has been instituted late. In other cases it is associated with the spontaneous rupture of the abscess. As the necrotic bone is small there is no objection to its immediate removal.

Periostitis of the Lower Jaw, with Partial or Total Necrosis. Clinically, the local and general conditions of these patients are such that they at once differentiate the disease from the inflammations of a milder degree. There are high fever and leucocytosis, and all the usual signs of general infection, and the local symptoms are much more severe. Now and then the disease is complicated by a distinct cellulitis. The lesion, as a rule, can be prevented by good dentistry, and its further spread may be arrested by an early incision of the parts involved in the alveolar periostitis. In a very few cases the infection travels so rapidly that within from twenty-four to forty-eight hours the entire lower jaw is involved in the inflammatory process. In these very acute infections one should not confine the incision to the mouth only, but incisions should be made in the neck and carried down to the bone. Multiple incisions are usually required. When the acuteness of the inflammatory process has subsided one should be very conservative in the removal of the dead bone. Wait until the periosteum throws out an involucrum of sufficient strength to preserve the contour of the jaw. The sequestrum should be removed in small pieces and at intervals.

The most unfortunate complication is the loss of the teeth. In two cases which I had under observation for a period of ten years, I was able to preserve the continuity of the lower jaw, but not the teeth. Both of these patients wear plates.

Secondary Infections of the Antrum from Alveolar Periostitis of the Upper Jaw.—For a discussion of this subject see page 879.

Secondary Myositis Leading to Ankylosis of the Lower Jaw. I will consider this complication when I come to describe lesions of the temporo-maxillary joint.

IV. TUBERCULOSIS OF THE JAWS.

From a clinical standpoint there is really no difference between pyogenic periostitis and osteomyelitis and tuberculous periostitis and osteomyelitis. The tuberculous infection resembles the subacute or chronic pyogenic infection, but, as it is quite possible for tuberculosis to be secondarily engrafted on the pyogenic, we may, in tuberculosis of the jaw, get a history of an acute onset. According to Perthes (*op. cit.*), tuberculosis of the periosteum and bone of the upper and lower jaws may be secondary to a tuberculous ulcer of the mucous membrane, or the infection may reach the jaw through a carious tooth, or it may be hæmatogenic.

In my experience, tuberculosis has always involved the lower jaw and has been characterized by multiple sinuses and large sequestra. All the cases which I have observed have been in colored children under ten years of age. Good results were obtained by rather conservative measures, such as removal of the sequestra and injections of iodoform emulsion into the sinuses, combined with the usual medical treatment for tuberculosis. There is nothing, therefore, except the naked-eye and the microscopic appearances of the tissues to characterize tuberculous periostitis and osteomyelitis of the jaw. One, however, may be suspicious of the existence of a tuberculous or an actinomycotic infection from the greater amount of induration in the soft parts about the sinuses. In tuberculosis, as in actinomycosis, the first sign of disease may be the presence of small abscesses in the mouth, along the alveolar border, or in the neck beneath the body of the lower jaw. Such chronic abscesses, however, are not impossible in a pyogenic infection. The point which I wish to emphasize is this: that in all abscesses in and about the jaw, especially when they have formed with but slight symptoms, a careful examination should be made for the presence of either the tubercle bacilli or the ray fungi, because the demonstration of one or the other, especially the ray fungus, indicates a more radical treatment than is required for the pyogenic infection.

When tuberculosis of the mucous membrane begins in the gum it gives rise to an ulcer which, I think, can always be differentiated from carcinoma. This ulcer has a ragged, undermined edge and it is free from any evidence of induration. When the ulceration reaches the periosteum this tissue is destroyed and there follows necrosis. In this form of tuberculosis of the jaw the disease may be limited to a small area.

In tuberculosis of the upper or lower jaw, which has originated through a carious tooth, the diagnosis at first is more difficult. The lesion is frequently observed in children, and the swelling about the tooth in the beginning of the disease does not differ from what is observed in a non-tuberculous case, but the persistence of a boggy, indurated swelling after treatment, or after extraction of the tooth, should make one suspicious. Cases of this nature are not diagnosed, as a rule, until typical tuberculous granulation tissue has formed and sequestration has taken place.

In tuberculosis of apparently hæmatogenic origin the clinical picture is somewhat different. The upper jaw, it has been found, is the one more frequently involved. A swelling makes its appearance over the infraorbital ridge; a small abscess and then a sinus develop in this locality, and a small sequestrum is discharged; healing may eventually take place, with slight ectropion of the lower lid. According to Perthes this course is quite characteristic; but I have observed a similar picture in what I thought was a non-tuberculous antrum infection, which spontaneously perforated just below the infraorbital ridge. In the three cases which I have seen the affected tissues were studied microscopically, and at the operation no evidence of tuberculosis was found. For this reason I am of the opinion that the clinical picture described by Perthes is not necessarily pathognomonic of tuberculosis. In young infants a hæmatogenic tuberculous process of the frontal or palatine bone may have a picture so similar to that of an empyema of the antrum that a differential diagnosis is possible only when we consider that at this age no antrum sinus exists.

In the lower jaw the disease begins, as a rule, somewhat acutely, without an ulcer on the gum or a carious tooth. One or more little lumps appear along the alveolar border and over the body of the lower jaw. Then the lymph nodes in the submaxillary triangle swell, and afterward sinuses develop in the mouth, along the alveolar border, and in the neck. In the latter locality they can be traced from the surface to the body of the jaw and to the lymph nodes. The description of Perthes corresponds exactly with what I observed in the two cases which came under my observation. In both of these cases the patients were colored children about five years of age.

Tuberculosis of the Antrum.—Although the diseases of the maxillary and other sinuses are considered elsewhere, I wish to call attention here to the possibility of the occurrence, in the antrum of an adult, of a tuberculous inflammatory process which cannot be distinguished clinically from sarcoma or carcinoma. Only a few cases of this nature have been reported in the literature.* I desire to refer to these cases, however, as further evidence of the importance of exploring the antrum before one subjects the patient to a typical resection of the upper jaw.

V. ACTINOMYCOSIS OF THE JAWS.

As my personal experience with this infection generally, and with its involvement of the jaw specially, is limited to a few cases, I must base this description chiefly upon the excellent résumé of Perthes.

Actinomycosis, when it involves the region of the jaw, presents itself most commonly as an infection of the soft parts alone. In a smaller number of cases it is observed as an infection of the soft parts with secondary involvement of bone; under these circumstances it must be differentiated from pyogenic and tuberculous periostitis and osteomyelitis. *In still another group of cases it appears as a primary central necrosis or as a central new-growth of the lower jaw, and must then be differentiated from tumors proper.*

When the actinomycotic infection presents itself clinically as an abscess in the region of the jaw there is nothing to differentiate it from some acute or chronic abscess due to other causes. When this abscess, however, is opened, careful observation will disclose the presence of sulphur granules in the thick, creamy pus. The diagnosis can be confirmed by microscopic examination.

Cases of this kind are not often observed first by the experienced surgeon, and bacteriological investigation has usually been omitted. Most frequently these patients present themselves with sinuses in the region of the upper or the lower jaw, or in both regions, and they give a history of multiple chronic abscesses which have ruptured or have been incised. Some of these sinuses open upon the surface of the skin, while others open into the mouth. In these cases, on palpation one is struck with the excessive amount of scar tissue which surrounds the sinuses. Next to the sulphur granules in the pus or granulation tissue, this hyperfibrosis in the base of the granulation tissue is a characteristic feature of actinomycotic infection, and when the bone is involved there is often hyperostosis due to an ossifying periostitis. The sinuses may be very numerous. (Fig. 623.)

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*Coenen, in Archiv f. klin. Chir., 1903, vol. lxx., p. 841; and Wolff, in Archiv f. klin. Chir., 1906, vol. lxxxi., ii., p. 221.

When there has been secondary involvement of the upper or the lower jaw from infection of the adjacent soft parts, there is nothing especially characteristic of the bone involvement to distinguish the lesion from tuberculosis or chronic pyogenic infection.

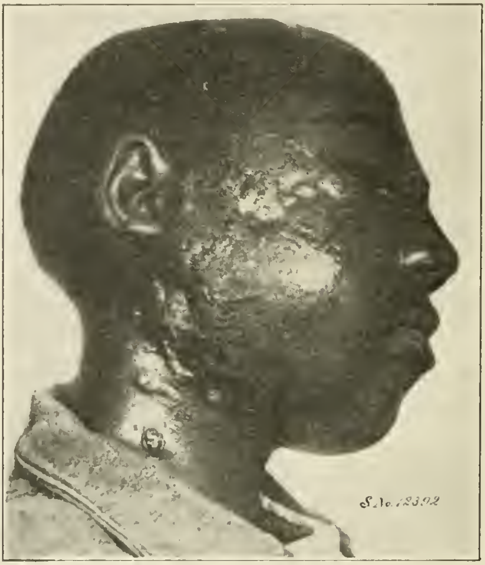

Fig. 623. Surg. No 12392. Johns Hopkins Hospital, Halsted's Clinic. Actinomycosis of Face, with multiple sinuses and abscesses about, but not involving, the jaws. Age seventeen years, symptoms nine months. Death at end of four and a half years, from general tuberculosis. Actinomycosis apparently cured.

The cases in which the actinomycosis involves the centre of the lower jaw are rare. They present themselves clinically as a swelling of the lower jaw, with one or more sinuses opening upon the surface of the mucous membrane, and on incision one finds a cavity filled with granulation tissue, pus, sequestra, and, in some cases, an involucrum. In a few instances the central bone abscess has been found to possess no communication with the external world.

In a very few cases the central actinomycotic infection, with its pus and granulation tissue, has given rise to an expansion of the outer shell of bone and the formation of a definite tumor-like growth with a bone capsule (Fig. 624). In these cases a differential diagnosis from a benign dentigerous cyst, a central adamantine epithelioma, or a sarcoma, cannot be made without an exploratory incision. As a matter of fact, in very many of these cases the diagnosis of central sarcoma has been made, and on the strength of this diagnosis total resection has been performed.

For the diagnosis of actinomycosis, therefore, the surgeon must constantly bear this infection in mind when he encounters lesions of any kind in the upper or the lower jaw, or in their immediate vicinity. The rule which I wish again to emphasize is that an exploratory incision should always be made before one resorts to total resection of the jaw. By means of such an incision the surgeon will be able to expose all central lesions to the naked eye. The pus and the actinomycotic granulation tissue should never be mistaken for a new-growth. In some cases the sulphur granules are so scanty that they may be overlooked. It should, however, be the rule in every case of infection to examine the pus and granulation tissue at once with the microscope before one resorts to the operative procedure.

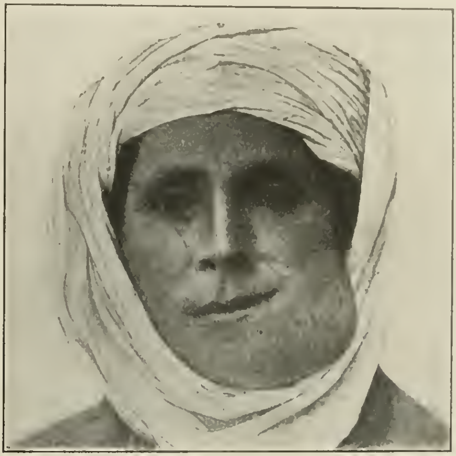

Fig. 624. Tumor-like Actinomycosis of the Lower Jaw. Observation of Legrain. (From Poncet-Bérard, "Traite clinique de l'actinomycose humaine.")

In the treatment of actinomycosis of the jaws the same principles apply as elsewhere, with some modifications. All authorities agree that these patients should receive potassium iodide in increasing doses. Bevan, of Chicago (*Jour. Amer. Med. Asso.*, Nov. 11th, 1905), recommends copper sulphate in doses of about five grains three times a day. Very few authorities are content with medical treatment only. Sawyers (*Jour. Amer. Med. Asso.*, May 11th, 1901), from his study of the literature, seems content with medical treatment and irrigation with potassium iodide. In 1899, John Ruräh, of Baltimore (*Annals of Surgery*, 1899, Vol. XXX., pp. 417, 605, and 722), collected all the cases which had been observed in America. His conclusions agree with those of Perthes and other German authorities.

Perthes advocates the conservative treatment. The abscess and sinus should be freely opened; the granulation tissue should be excised or curetted; disinfection should be instituted with pure carbolic acid, iodine, or the Paquelin cautery; the wound should be packed and allowed to heal from the bottom by granulation; and the disinfection should be kept up until the wound has completely healed. Perthes calls attention to the fact that in central actinomycosis of the lower jaw the results have been just as good after conservative operations as when total extirpation (resection) has been carried out.

The prognosis for lesions in and about the lower jaw has been unusually good. Apparently about ninety per cent have recovered, while for infection of and about the upper jaw the reverse is true. This result is doubtless due to the fact that, when the infection has penetrated to the fossæ at the base of the skull behind the lower jaw, there is danger of secondary involvement of the brain or the spinal cord. This result was observed in one of my cases about eight years after the onset of the infection.

There is no doubt that cases of actinomycosis have been cured, and many of the patients have been followed for a period of more than five years; but the percentage of cures recorded in the literature is based upon observations which covered a period of only two years—a period which I do not think to be sufficiently long. It is my opinion that the last word as to the operative treatment of actinomycosis has not been said, and I must confess that I agree with Kiseritzky and Bornhaupt (*Archiv f. klin. Chir.*, 1905, Vol. LXXVI., p. 835), who state that, in the treatment of actinomycotic as well as pseudo-actinomycotic infections, radical removal of the focus should be done if possible.

Radical operations are best performed in the early stage and as a rule they can then be accomplished without mutilation. Such an operation is possible only when all centres of infection are subjected to proper bacteriological examinations. In neglected and improperly treated cases radical removal may be impossible. One must, therefore, under these circumstances, rest satisfied with the usual measures. It must be remembered, however, that a free interval of two or even three years is by no means an indication of a positive cure. During this time the infection may remain dormant, as in tuberculosis, and then break out again. This occurred in one of my cases four years after apparent recovery.

VI. SYPHILIS OF THE JAWS.

I again must turn to Perthes, as my own experience has been somewhat limited. The luetic infection here does not differ from that observed in other parts of the body. We have the syphilitic ulcers of the mouth, which may be primary, and mucous patches. The latter are secondary manifestations, and rarely, if ever, lead to involvement of bone. There are two forms of lesions which affect the bony structures of the jaws: the diffuse and the circumscribed gumma and syphilitic periostitis. The latter form of syphilitic disease may cause either destruction of the bone substance or simply hyperostosis. The most common lesion is a perforation of the hard palate. This may begin first as a circumscribed area of induration on that part of the jaw. If such a case is seen early it may easily be mistaken for sarcoma, but in my experience a gumma here is usually more diffuse than a sarcoma. As a rule the gumma breaks down within two or three weeks, an ulcer forms, the thin shell of bone is destroyed, and a perforation takes place into the nose. The lesion, however, may begin as a gumma on the nasal side of the hard palate. After perforation has taken place the diagnosis should not be difficult. I have never had the opportunity to see this lesion in the early stage, before the perforation has taken place.

Perthes describes a diffuse gummatous periostitis of the alveolar border which may involve either the upper or the lower jaw. It begins with a diffuse swelling of the gum and is followed by loosening and falling out of the teeth, purulent inflammation, and finally necrosis of the alveolar border. I have never observed such a lesion in syphilis. The diffuseness which characterizes the process in the early stage should, it seems to me, distinguish it from a sarcoma. In the stage of ulceration it should be easily distinguished from carcinoma by the absence of induration.

The syphilitic periostitis may attack the infraorbital ridge and produce lesions which resemble those of tuberculosis. (See the description which I have given on page 881.) In both the upper and the lower jaw, especially along the alveolar border, the syphilitic periostitis may be associated with the formation of new bone (ossifying periostitis). This is hard to distinguish from the nonsyphilitic ossifying periostitis (page 816). In all these cases of ossifying periostitis the therapeutic treatment for syphilis should be employed before operative treatment is instituted.

In syphilitic lesions of the upper and lower jaws, with bone destruction or with hyperostosis, there may be neuralgia due to the involvement of one of the branches of the fifth nerve. This should always be borne in mind, and such patients should receive the specific treatment. My associate at the St. Agnes Hospital, Dr. McGlannan, has recently had such a case under observation.

VII. TOXIC INFLAMMATIONS OF THE JAWS WITH NECROSIS.

Phosphorus Ostitis and Periostitis.—There is relatively little on this subject in American literature. In the index of the Transactions of the American Surgical Association from Vol. I. to Vol. XX. (1902) there is but one reference to phosphorus necrosis of the jaw (1885, Vol. III., p. 357).* One interested in the subject will find it fully considered by Perthes, who practically bases his chapter on the monographs of Haeckel and Trendelenburg and the experimental work of Wegner in 1872. It is interesting to note that the first case of phosphorus necrosis of the jaws was observed in 1839 by Lorinser, six years after the beginning of the manufacture of phosphorus matches. His diagnosis at that time was syphilis, but, when he published his work in 1845, the relation between phosphorus and necrosis of the upper and lower jaws was already fully established.

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* Dr. James R. Wood, of New York, was the first in this country to give an account of this disease, illustrated with striking examples of conservatism in the reproduction of the lower jaw. —J. D. Bryant, Editor.

When the extent to which phosphorus poisoning occurs among workmen who come in contact with this metal became fully known, governments promulgated laws for their protection; but, in spite of this, the disease, although less frequent, is still observed. We should be on the lookout for the disease in this country, because it may break out as long as from three to four years after the workman has left this occupation. In fact, in one case, the latent period was nineteen years.

In the majority of cases the lesion does not manifest itself until the individual has been in contact with phosphorus vapors for a number of years—on an average, from five to eight. It has been observed, however, at periods which vary from a few months to twenty years after the adoption of the harmful occupation.

At the present time it is the consensus of opinion, based upon experimental work and clinical observation, that phosphorus, in addition to the effects which it produces on various tissues of the body, gives rise throughout the entire skeleton, in different places and in different degrees, to a chronic ossifying periostitis and ostitis. This at first makes the bone denser, the marrow cavity narrower, and the surface of the bone beneath the periosteum rougher; and it also renders the stripping off of the periosteum easier. Later, there may be osteoporosis, even up to a point of fragility which may be associated with multiple pathological fractures. This is unusual. In the jaws, and particularly in the lower jaw, the ossifying periostitis, with its osteophytic formations, is more marked than in the other bones of the skeleton. All the other pathological changes of the so-called phosphorus necrosis depend upon secondary infection through a carious tooth in a jaw the resistance of which has been lowered, not only as regards an infection at one point, but also as regards the progressive spreading of the infection to other points. For this reason, in the lower jaw, the disease gradually extends until the entire bone is destroyed. Regeneration, however, usually takes place—as a rule incompletely—through involucrum. Most frequently the teeth are lost. The joint may become involved and, in rarer instances, the infection extends through the skull, with the production of meningitis and, ultimately, of cerebral abscess. The disease is less frequent in the upper jaw, and, as is the case with other forms of infection, the necrosis is less extensive there, but the danger of meningitis and cerebral abscess is greater.

The diagnosis would be suggested by the patient's occupation or by the history which he gives of his malady. The *x*-ray in early cases would show the characteristic bone changes of phosphorus poisoning, which would be the only signs that distinguish the affection from other forms of osteomyelitis.

The treatment should be the same as that already discussed for other infections which are accompanied by necrosis of the jaws.

Arsenical Ostitis and Periostitis.—Just as surgeons may, by the use of carbolic acid, produce burns or gangrene, so dentists, in their employment of white arsenic, may produce a local necrosis of the alveolar bone about the tooth to which arsenic has been applied for the purpose of killing the nerve. This must be a very rare accident in good dentistry.

From experimental and clinical data it is an established fact that arsenic produces the same changes in bone as phosphorus does, and when, in the lower jaw, a portal of entrance is given by a carious tooth, there may be the usual necrosis; but, as compared with phosphorus necrosis, the arsenical form is very rare.

Mother-of-Pearl Periostitis.—According to Perthes this disease was first described in 1870 by Englisch in Vienna. The effect of this poison resembles somewhat that of phosphorus, in that the jaw is only one among many bones involved. It is very interesting to note, however, that the painful swellings subside. Up to the present time there is not a record of a single case having been subjected to operation nor of a piece having been excised for diagnosis. No *x*-ray photographs appear to have been taken. Apparently it is a form of periostitis, but without the formation of new bone.

Mercurial Stomatitis.—This may lead to periostitis of the jaw with necrosis, but the infection of the jaw is entirely secondary to stomatitis, and there is no evidence to indicate that the mercury plays any part.

VIII. DISEASES OF THE MAXILLARY JOINT.

This joint may be involved as a primary arthritis by itself, or it may be simply a part of a polyarthritis.

As regards the ankylosis which follows arthritis in youthful individuals, it is an interesting fact that this condition is followed by a cessation of development and growth of the lower jaw—micrognathy. (This deformity will be considered in the next section.)

In my experience the majority of cases of ankylosis of the lower jaw are due to extra-articular inflammations—*e.g.*, myositis, secondary to an infection of the tooth. In these cases division of the contracted fibrous muscles relieves the ankylosis. When the ankylosis is due to the effect of a burn or wound of the external skin and muscles, plastic operations of various kinds are in order, and, as shown by the communication of Alessandri (*Deutsche Zeitschr. f. Chir.*, 1905, Vol. LXXIX., p. 548), they may tax the ingenuity of the surgeon.

In gonorrhœal arthritis, according to large statistics, the jaw may be involved in about five per cent of cases. This, in my experience, is rather large; in fact, I have never observed a case in which ankylosis resulted.

If one is called upon to make a differential diagnosis between acute articular rheumatism and the so-called arthritis deformans, the involvement of the jaw may be interpreted as favoring the latter disease. I can find no records of involvement of the temporo-maxillary joint in tabes dorsalis or syringomyelia. It is rarely one of the joints involved in the polyarthritis of infectious diseases. Perhaps the most common primary lesion, next to traumatism with direct opening of the joint and osteomyelitis of the jaw itself, is otitis media.

The treatment of arthritis follows the principles employed in the involvement of other joints. For draining a purulent collection which, as happens in the majority of cases, has ruptured into the temporal fossa, and for exposing the joint in the operation for resecting the head of the bone on account of ankylosis, one may best reach the joint by splitting the temporal muscle and, in some instances, by resecting at the same time the zygoma.

IX. DEFORMITIES OF THE JAWS.

As stated before, micrognathy is the most interesting of these deformities. It is due to ankylosis which has taken place in one or both temporo-maxillary joints, in younger individuals, before the lower jaw has reached its maximum growth. This deformity is another evidence of the truth of Wolf's law, which states that the growth of bone depends upon the constant action of its function. If motion is prevented in the jaw because of ankylosis, the jaw does not develop. The deformities of the jaws are fully considered by Perthes, and the operative treatment of micrognathy is fully discussed in a recent monograph by von Auffenberg (*Archiv f. klin. Chir.*, 1906, Vol. LXXIX., p. 594. The article is illustrated). In the matter of treatment, the head of the bone is first dissected, and then an osteoplastic lengthening of the body is accomplished on the affected side. In bilateral cases one must resect the head of the bone on both sides, while the osteoplastic procedure is limited to the region of the symphysis.

The condition is very rare, and the surgeon who happens to meet such a case should consult Auffenberg's contribution.

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